EXTENDED ABSTRACTS FOR AN INTERNATIONAL CONFERENCE ON "THE DEVELOPMENT OF THE NORTH AND PROBLEMS OF RECULTIVATION"

July 8-14, 1991

The Russian Academy of Sciences
Ural Division
Komi Scientific Centre
Institute of Biology
Syktyvkar

BYRD POLAR RESEARCH CENTER
THE OHIO STATE UNIVERSITY

BPRC Miscellaneous Series M-334

BYRD POLAR RESEARCH CENTER,
THE OHIO STATE UNIVERSITY
COLUMBUS,OHIO 43210-1002

EXTENDED ABSTRACTS
FOR AN
INTERNATIONAL CONFERENCE ON

"THE DEVELOPMENT OF THE NORTH AND PROBLEMS OF RECULTIVATION"

July 8-14, 1991

The Russian Academy of Science
Ural Division
Komi Scientific Centre
Institute of Biology

Syktyvkar

BPRC Miscellaneous Series M-334

Compiled in 1994 by the
BYRD POLAR RESEARCH CENTER

This report may be cited as:

Extended Abstracts for an International Conference on "The Development of the North and Problems of Recultivation", July 8-14, 1991, Syktyvkar, Russia. 1994. *Byrd Polar Research Center Miscellaneous Series M-334*, Byrd Polar Research Center, The Ohio State University, Columbus, Ohio, 151 pages.

EDITOR'S NOTE:

This compendium of abstracts was assembled from post conference, Russian to English, translations done in Syktyvkar. I have tried to confine the editing of these translations to smoothing the English without altering the intent or sense of the original. Where I have failed in this I accept full responsibility and offer apology to the author(s) and to the reader.

City names and country designation have been changed to conform to current usage, except for the conference resolutions accepted by the attendees. Currency values remain as they were in 1991. Plant and animal taxonomic designations have not been altered nor have volumetric, granmetric or scalar values.

For the readers convenience the abstracts have been organized under broad topic headings rather than in alphabetical sequence as they were formulated originally.

K.R. Everett, Professor
Byrd Polar Research Center and
Department of Agronomy
The Ohio State University

Copies of this and other publications of the Byrd Polar Research Center are available from:

Publication Distribution Program
Byrd Polar Research Center
The Ohio State University
1090 Carmack Road
Columbus, Ohio 43210-1002
Telephone: 614-292-6715

ACKNOWLEDGEMENTS

On behalf of the American attendees I would like to express our gratitude to the Ural Division of the Russian Academy of Sciences; the Komi Scientific Centre Institute of Biology; to the Director of the Institute, Dr. A.I. Taskaev; and the Conference Organizing Committee for producing a highly organized and stimulating conference, and post conference field excursion, as well as, to the many personal kindnesses shown us throughout our stay in Syktyvkar and Vorkuta by the many people who organized and supported conference related activities.

I would like to acknowledge the dedication and skill so apparent in the Russian-English translations from which I worked and to Lynn Tipton-Everett for her considerable efforts in processing and formatting the text. Also, I gratefully acknowledge the U.S. Department of Energy which provided support toward the publication costs of this volume.

CONFERENCE ORGANIZING COMMITTEE

Chairman: Yu.I. Chernov
President of the Science Council of fundamental investigations program: "Ecological problems and anthropogenic dynamics of biological systems", Associate member of the Russian Academy of Science.

Vice-Chairman: A.I. Taskaev
Director of Institute of Biology, Komi Scientific Centre, Candidate of Biological Science.

Vice-Chairman: I.B. Archegova
Chief of Laboratory, Institute of Biology, Komi Scientific Centre, Candidate of Agricultural Science.

Secretary: N.S. Kotelina
Senior scientific worker, Institute of Biology, Komi Scientific Centre.

Other Members: G.K. Androsov
Syktyvkar State University, Doctor of Biological Science.
A.A. Ermakov
Vice-chairman of the Komi State Nature Committee, Candidate of Biological Science.
M.A. Magomedova
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Candidate of Biological Science.
V.A. Fedorovich
Pro-rector of Syktyvkar State University, Candidate of Philosophical Science.
N.P. Akulshina
Assistant Professor at Syktyvkar State University, Candidate of Biological Science.
O.V. Kutsil
Chief of Section for "Severgasprom" Trust.
L.M. Nosova
Scientific Secretary of the Science Council of the program "Optimal Using and Wide Reproduction of Biological Resources, Candidate of Geographical Science.

Working Secretariate

Organizing questions: N.V. Andreeva, V.M. Kush, E.V. Overina and L.P. Turubanova.
Foreign section: E.I. Shteiner.

PREFACE

Ecological problems in many regions on Earth are the result of increasing technological pressure on the environment. There problems concern many of us and cause us to unite in order to search for means to protect our "natural house". Scientists, especially are responsible for the protection of the biosphere.

The objective of this conference which took place in Syktyvkar, capital of the Northern Republic of Komi in Russia, was to discuss the results of studies on the present condition of the environment in the Far North where the industrial pressure is increasing. The participants of this conference also offered and suggested various necessary measures for the protection of the region and restoration of its disturbed sites.

The specific structural characteristics of the environment of the Far North, tundra and northern taiga, cause its fragility and vulnerability to anthropogenic impact. The destruction of the thin, weak layer of soil and vegetation cover changes the thermal balance and thus causes the development of erosion process, which in their turn increase the zone of the direct technogenous destruction. Self restoration processes in this harsh climate usually are slow. The preservation of the ecological integrity in the Far North is essential for the stability of the biosphere of the planet.

We must take into account the specifics of the natural conditions so that we will be able to develop the means of intensive agro-technology that can speed up the process of restoration of the biocenosis in the damaged areas.

The extended abstracts of the conference reports that constitute this volume contain both theoretical discussions of problems of recultivation as well as accounts of experimental studies and applied explorations.

After the conference, a scientific field trip was conducted to the Vorkuta region (the largest coal mining region of the North-Eastern part of the European tundra). The participants of the conference familiarized themselves with the different types of tundra landscape as well as with the technologically produced damages of the natural ecosystems. Special attention was given to observations of the tundra agro-landscapes. The methodologies of which were developed by the researchers from he Institute of Biology of the Komi Center of Science (I.B. Archegova, I.S. Khantimer, N.S. Kotelina) (... so this method) was used for creation of the sown meadows of many years' standing and their efficient usage. Their long term efficiency yields of 20 to 25 centner/hectare of dry mass/year provided by the sowing of local types of many years' living grass which are adjusted to the harsh climate. These agrocenoses which have been seeded now for many years could last for 30 years or more being ploughed again if they are taken care of properly. This method is accepted as the basic device for biological recultivation; it (the method) ensures the restoration of the fertile layer on the technogenic areas within 5 to 7 years. The faster replacement of the grass association by that which is typical for this zone, takes place in the future.

The Organizational Committee of the conference expresses gratitude to Dr. K.R. Everett who kindly undertook the preparation of the papers and reports of the conference for publication in English. No doubt, it will ensure the fulfillment of the original goals of this conference. WE hope that this will also help to organize the II International Conference which our Organization Committee suggest to hold in early 1994 in Syktyvkar. Despite the current economic hardships the Committee anticipates the participation of foreign colleagues in this conference, which will help to strengthen contacts and the exchange of scientific ideas which are indispensable for the solution of the multiplicity of environmental problems (particularly in the North) and assist in maintaining favorable conditions for the life of the people on this planet.

I.B. Archegova
Deputy Chairman of the Organizational Committee

TABLE OF CONTENTS

PLENARY SESSION

Welcome Address: V.I. Khudyaev, the chairman of the Komi Council of Ministers.

Conference Opening : A.I. Taskaev, director of the Institute of Biology, Komi Scientific Centre.

Presented Papers:

Biological recultivation in the North: theory and practice.
I.A. Archegova, N.P. Akulshina, N.S. Kotelina. Syktyvkar.

Microflora of the oilfields in the Komi Republic and the prospects of using biological recultivation of the polluted soil.
G.K. Androsov. Syktyvkar.

Land protection in the Komi Republic: present state, development and problems.
A.A. Ermakov. Syktyvkar.

Unified for especially protected natural territories in the country, and some ways of forming the regional systems.
L.S. Isaeva-Petrova, S.E. Karaseva. Moscow.

Regional and economical aspects of soil recultivation.
V.I. Spiryagin. Syktyvkar.

Genetical and biological aspects of soil micromorphology in the focus of recultivation problems.
H.J. Altemuller. Germany.

SECTION 1: POLLUTION

COMPLEX MONITORING OF NORTHERN ECOSYSTEMS ON THE PRESERVED TERRITORIES

T.B. Chicheva and Yu.P. Cherkhanov
Institute of Global Climate and Ecology of the Russian Goskomgidromet, Russian Academy of Sciences, Moscow

The Russian Goskomgidromet organized detailed background monitoring of pollution to determine the content of pollutants in the environment on both a regional and global scale. The system of detailed background monitoring is aimed at observing gaseous and aerosol components in the atmosphere, the chemical composition of precipitation, snow cover, soil, river, lake and sea waters, and animals and plants. It also estimates the condition of terrestrial, freshwater and marine biological systems.

A set of stations for detailed background monitoring (SCBM) organized together with the Russian Goskompriroda play an important role in monitoring environmental pollution. The network covers all natural zones of the country.

One third of the territory of the country (Russia) is occupied by ecosystems of cold and moderate climates. They are of great ecological and economic importance. The level of agricultural development in these forest covered territories is low, not more than 13 percent. Logging, forest fires and atmospheric pollution have serious anthropogenic effects on the forests. The main indices that characterize the state of the ecosystems in the forest zone and their resistance to pollution are: the acid-alkaline balance in the soil, actual and combined acidity, the content of exchangeable cations and the level of complex (base) saturation.

Before a single (coordinated) program of observations (SCBM) can be developed for the forest and tundra ecosystems it is necessary to take into consideration their biogeochemical characteristics as they influence the study and modelling of the transport of pollutants within these regions. The following types of observations and measurements are required: 1) in the atmosphere - SO_2, NO_2, sulfates, Zn, Cd, Cu, Pb, Al; 2) in atmospheric precipitation (rain, snow) the measurement of concentration in surface discharge of Pb, Cd, Cu, Zn, sulfates, chlorides, acetates, hydrocarbons, NH_4, Na, K, Ca, Mg, together with measurements of pH, alkalinity and electrical conductivity; 3) in the soil and debris layer the concentration and content of mobile forms of Pb, Cd, Cu, Zn, Mn, and the measurement of pH (H_2O and KCL) an estimation of the content of aluminum, bound and exchangeable, organic carbon, S (bound), N and exchangeable cations (Ca, Mg, K, Na); 4) in surface, soil solution and ground water the measurement of the concentration and discharge of Pb, Cd, Cu, Zn, Al, Mn, sulfates, chlorides, acetates, hydrocarbons, NH_4, Na, K, Ca, Mg, total sum of ions, and pH; 5) in woody vegetation (needles, foliage) the concentration and content of Pb, Cd, Cu, Zn, Mn, Mg, Ca, S (bound), N (bound), P (bound); 6) in mosses, the concentration and

content of Pb, Cd, Cu, Zn, S (bound); and 7) in animal organisms, the concentration of Pb, Cd, Cu, Zn, Mn.

The final step in the estimation of ecosystem state is an evaluation of the spatial and functional organization of phytocenoses. The results of theoretical and practical investigations of ecologically important factors and processes that define the state of biogeocenoses make it possible to use phytocenoses as the key and integral index of the state of the surface native systems (ecosystems). The effect of negative anthropogenic effects on ecosystems may be revealed as follows:

1. A decrease in productivity of the phytocenose-indicators
2. Changes in the rate of natural phytocenotic successions
3. A jump-like reversible or irreversible alternation of successions
4. Changes in organizing (functional structure) of the biocenoses
5. A succession - anthropogenic desert.

For the base-line areas in coniferous ecosystems the following field observations are suggested:

1. Estimation of indicators of production and destruction of organic matter of the woody layer, including indexes of disturbance and needle choice (condition) according to the years and biometrical indexes of the current year shoots (length and mass of a shoot) length, number, mass and color of a wood-layer.
2. Dendrometric survey of the woody layer.
3. Lichenometric survey with information on quantitative characteristics of the epiphytes.

The suggested detailed program of observations is aimed at organization of field work in the basins of smaller water bodies and supported by hydrometeorological observations. We hope it can provide all the necessary parameters for the estimation of pollutant migration in the ecosystems investigated, estimate changes in chemical and biological indexes of ecosystems which take place in response to anthropogenic loading and to develop forecasts for changes in their state.

IMPACT OF OIL SPILLS ON AMPHIBIA POPULATION

M.N. Danilova
Yekaterinburg

Development of the northern territories results not only in the landscape change, but subjects the fauna to anthropogenic stress. That is why term recultivation covers not only soil and vegetation recovery but also includes the study of the consequences of human activity on the wildlife population.

Comparatively regular oil spills on the oil drilling rigs and during transportation in northern regions causes a constant stress on the ecosystem the stability of which depends on the stability of the organisms having key positions in the structure of the biocenoses. Amphibia are such organisms. The dual habitat of those animals makes them a convenient subject for the study of the effect of contamination, especially at the larva stage.

The effect of crude oil on the growth, development and metamorphic climax of two widely distributed amphibia species was studied: *Rana arvalis* and *Rana temporaria*. In the experiments oil with a specific gravity of 0.838 mlg/cm^3 was used. In laboratory conditions two main types of water contamination have been simulated: 1) oil on the water surface; 2) oil on the bottom of a potential water pool. After weathering of the oil the pool is filled with water.

Tadpole groups (30 animals in every group) at the 25th - 26th stage of development were used for experiments. Three each were placed into cylindric 3-liter aquariums where one of the situations described above was modelled. The animals were kept there until metamorphic climax occurred. The range of oil doses was 0.0005 to 0.500 ml/l. In every experiment there were control series where pollutants were absent.

During the experiments survival of larvae, weight and body length, the change of development stages and period to metamorphic climax were recorded. Specific energy expenditures on metamorphosis were also calculated.

The following results were obtained: 1) lethal dose of oil for *R.arvalis* equalled 0.05 ml/l and for *R.temporaria* - 0.025 ml/l; 2) sublethal doses (below the above values) could inhibit larvae development and stop the metamorphosis for 12 days compared with the control; 3) oil doses up to 0.01 ml/l stimulated larvae development and they outstripped the control when passing to the 27th and 28th development stages; 4) lethal doses increased by ten times if there was sand at the bottom of the aquarium; 5) depression of larvae growth occurred only at lethal oil doses; 6) specific energy expenditures on metamorphosis in control and the experiment were similar.

The data have proved that in amphibia that survived in the presence of oil, growth and energy processes are not suppressed, but the rate of development slows which makes larvae more accessible to prey animals and prevents their reaching the surface during the short northern summer. This may result in a higher rate of death of larvae and amphibia which will in turn be unfavorable for the population structure

THE SECONDARY PURIFICATION OF SEWAGE WATER AFTER BIOCHEMICAL TREATMENT

V. Davydov, G. Osipova, R. Brezhneva and P. Osipov
Komi Science Centre, Ural Division, Russian Academy of Sciences, Timber Industrial Complex, Syktyvkar

The great importance of environmental protection, especially the protection of water resources, make it necessary to pay special attention to the purification of everyday and industrial sewage waters before their discharge into natural water bodies. The most popular mechanism is biological purification, especially when the volume of sewage waters is large. However, it has a number of significant defects, of which the main are: the high content of the exposed organic substances, the presence of phenolic compounds and the high content of suspended substances in the purified waters. In this paper consideration is given to and some results of the secondary chemical purification of sewage waters after biological purification.

Secondary chemical purification produces the most significant following after biological purification, with the expenses of the reagents being minimal. As the major reagent we propose a hydroscopic salt of titanium - titanium sulphate and ammonium. Titanium is one of the strongest complex formers and it reacts with all classes of organic compounds yielding non-hydrous compounds, which are the basis of the principal of purification. The results of the investigation have shown that the use of oxygen by sewage waters purified with the help of titanium sulphate and ammonium can be reduced 60 to 80%. The best results have been obtained during treatment of compact active silt with a mixture of titanium sulphate and ammonium and aluminum sulphate, using 0.5 to 0.8 kg per m^3. The rate of sedimentation of active silt, in fact does not depend on amount of titanium sulphate and ammonium and aluminum sulphate, but to significant extent depend on the nature of flocculent.

A two-stage treatment of active silt has been proposed. 1) In the first stage it is suggested that the rate of sedimentation be increased which permits a decrease in the volume of active silt in the silt-compacting body and to decrease the content of suspended substances; 2) in the second stage to increase the rate of filtration processes and to decrease the content of the hydroscopic organic substances. During this process a silt of high quality can be used which contains biologically active complexes of titanium (IV).

THE AFFECT OF ANTHROPOGENIC INFLUENCE ON SOIL ALGAL FLORA IN THE "MEDVEZHYE" FIELD

I.E. Dubovik, A.R. Ishbirdin and A.F. Khusainov
Bashkir State University, Ufa, Russia

The algal flora of the forest tundra of "Medvezhye" gas field has not been studied yet. Data on the soil algal flora in the region of tundra and forest tundra are unique (Dorogostaiskaya, 1959; Shtina, 1976; Shtina and Golerbakh, 1976). We have studied the algal flora of plant communities on tundra soils under conditions of anthropogenic impact.

The following plots were studied: 1) under communities of *Ledo (Ledium)-Sphagnetum fuscii*; 2) under the derivative communities of this association after fire with *Rubus chamaemorus* dominating; 3) under *Salix spp. - Betula nana* communities; 4) under *Empetrium-Chamerietum angustifolium*; 5) bare spots in willow-bushy tundra; 6) in plots seeded with local cereals; 7) in a plot with seeded with cultured cereals; 8) in a plot to which the anti-erosion substance "Universin-V" had been applied. The comparative characteristics of the algal flora is given in Table I.

TABLE I

Composition Of Algal Flora In Plots Under Study According To Systematic Groups And Life Forms

GROUPS AND FORMS OF ALGAE	NUMBER OF ALGAE SPECIES ----- plot numbers -----							
	1	2	3	4	5	6	7	8
Blue-green	1	2	2	-	4	-	1	
Green	12	14	13	8	6	17	14	-
Yellow-green	1	1	1	1	2	1	-	-
Chrysophyceae	-	-	-	1	-	-	-	-
TOTAL SPECIES	14	17	16	10	12	18	15	0
Ch - form	7	7	6	3	3	9	6	-
C -	3	3	4	2	3	2	3	-
H -	1	1	2	2	1	5	3	-
X -	2	4	1	2	2	1	2	-
C -	-	1	2	-	2	-	1	-
Hydr.	1	1	1	1	1	1	-	-

The algal flora studied is poor including only 37 species. This may be explained by unfavorable climate conditions, acid reaction of the soil solution, intensive development of above ground vegetation having standing crop cover, in some places, up to 80 to 100 percent.

In soil samples containing "Universin-V" no algae were found. This is evidence of toxic affect of this material on algae. Mosses and other higher plants were also absent, although more than 3 years have passed since the application of this material.

The appearance of the filamentous algae *Leptosira madiciana* in the 4th and 6th plots testifies to the gradual recovery of the algal flora. The rather high value of the Syerensen coefficient (50%) between algal flora in plots 6 and 7 showed that in plot 6 with seeding of local cereals (standing cover 50%) the greatest variety of species was observed. This may be explained by a rhizospheric effect. In plot 7 the seeding of cereals from other regions was found to be ineffective (standing cover - less than 10%, and no rhizospheric effect).

Thus, these investigations showed the high efficiency of biological recultivation with the use of grass-mixtures from local cereals and that the use of the anti-erosion substance "Universin-V" is undesirable.

PECULIARITIES OF NATURAL PHYTOCENOSES FORMATION IN TECHNOGENIC LANDSCAPES OF THE TUNDRA ZONE

O.A. Druzhinina
All Russia Research Institute of Nature, Moscow

Russian and foreign experience has shown that success in recultivation of disturbed lands of the extreme North may be achieved by relying solely on the use of local plant species and by applying the knowledge of successional processes of natural re-vegetation of disturbed lands. That is why it is important to identify all kinds of local flora, dominants of derivative communities, already tested by nature for survival in conditions of anthropogenic habitats. A summary list of the main cenose-forming plants of derivative communities for the tundra zone of Russia has been compiled. This list consists of 120 species recorded at different types of anthropogenic habitats in the centers of development in the North. The volume and composition of the list is evidence that the resources of tundra plant species, capable of recultivation in different subzones and regions is rather wide and diverse. In the course of the analysis of the list some peculiarities of derivative plant formations in the tundra were revealed.

The number of the principal cenose-formers of the tundra derivative plants increase from north to south. In the northern-most subzone of the high-arctic polar tundra (polar desert) eight species were recorded; in the arctic tundra subzone - 28 species and in the northern hyperarctic zones - 46 species. The greatest species diversity was recorded in the southern

hypoarctic tundra - 91 species. The coefficient of similarity between floras of anthropogenic habitats of adjacent subzones (according to Zhakkar) are not very high: 29.8% - for a pair of subzones of arctic and northern hypoarctic tundra; 23.4% - for northern and southern hypoarctic tundra and 9.1% - for high-arctic and arctic tundra.

Only one species - *Alopecurus alpinus* - is found in anthropogenic habitats in all subzones, but its cenotic role is not the same in all subzones. It plays its greatest role in the arctic and northern hypoarctic tundra subzones, while to the north and south of these its cenotic role as a plant derivative decreases. There are some species characteristic for all the subzones, excluding the high-arctic tundra: *Poa arctica*, *Calamagrostis holmii*, *Carex stans*, *Eriophorum scheuchzeri*, *E. angustifolium*, *Polygonum viviparum*, *Polemonium acutiflorum* and *Tripleurospermum phaeocephalum*. A number of species are not found in anthropogenic habitats of the southern hypoarctic tundra, but are present in arctic and northern hypoarctic tundra and northern subzones: *Poa alpigena ssp. colpodea*, *Phippsia algida*, *Cochlearia arctica*, *C. groenlandica*, *Parrya nudicaulis*, *Saxifraga cernua*, *Polemonium boreale*, *Senecio atropurpureus* and *Salix fuscescens*. Short term dominants, fluctuation explerents (early-successive species) as well as species that play a secondary role in derivative phytocenoses have a wide amplitude, spreading from north to south. Long-term dominants, successive explerents (late-successive species), that form stable phytocenoses in technogenic landscapes have subzonal specificity - each subzone has its own composition of such species. These are the species to be focused on in selecting plants for recultivation. This is done knowing the general natural laws governing the anthropogenically forced response of the plant cover in the extreme North. It is necessary to know the succession, duration, species composition and phytocenotypic composition of the succession stages; the zonal-regional specificity, as well as the life strategy of species, their ecological demands and geographical range.

RESISTANCE OF SOILS OF THE TAIGA LANDSCAPE TO THE INFLUENCE OF ACID PRECIPITATION

L.A. Grishina, M.I. Makarov, N.P. Nedbaev, R.M. Okuneva and T.A. Paramonova
Moscow State University, Moscow

The development of the energy production and industrial complex accompanying the development of the northern regions has resulted in an increase in the emission of sulphur and nitrogen oxides into the atmosphere. The effect of these acid pollutants on ecosystems now has a global character and is one of the most critical problems effecting forest biogeocenoses.

In a laboratory modelling experiment the influence of simulated acid precipitation with pH ranging from 4.5 to 2.5 was studied on soils of different facies from the taiga landscape: these included acid sandy podsolic soils with low humus content in a bilberry-pine forest and a pine forest with *Hylocomium*, *Dicranum*, *Phytidiadelphus* species; medium acid brown

forest soils with an average humus content in spruce forest, and neutral, organic rich alluvial mold-gley soils in a pre-river bed rich in herbs.

Extracted vegetative samples included undisturbed soil monoliths consisting of AO-AO/A2-B_{fh}-B1 horizons of a podosol, the AO-A1-AB-B1 horizons of a brown forest soil and the upper part of a thick mold horizon (A_h) of a mold-gley soil. The acidity of precipitations was simulated using sulphuric acid. Distilled water with a pH_ 5.6 was used as the control.

As a result of the simulated 5-year influence of acid precipitation on the soils under study, considerable changes of properties took place in the podsol. Under the extreme proton load (pH of solutions is 2.5) the reaction of forest litter decreased by 1.6 units of pH, exchange acidity increased 3 times and the concentration of exchangeable Al^{3+} increased to 18 m-eqv/100 g, which is toxically dangerous for the root system of plants. The content and the degree of saturation of the soil absorbing complex by exchangable bases decreased between 7 and 8 times. In additions 90% of exchange Ca, 83% of exchange Mg, 56% of exchange K were leached from forest litter which is the main concentrator of biogenic elements in podsols.

In mineral podsol horizons the acidification processes were less noticeable because there were only a small quantity of vacant ion-exchange positions able to adsorb additional acid ions. In addition, the acidity of model solutions was neutralized within forest litter to a considerable degree. it was determined that with simulated acid precipitation at pH 2.5 changes in podzolic properties were analytically confirmed throughout the monolith thickness; at pH=3.0 the upper part of soil was affected including the alluvial horizon; at pH=3.5 the change was observed only in the forest litter; and at pH>3.5 no change was observed. In the brown forest soil, the ion exchange capacity, high bare saturation and the influence of residual carbonacity of the parent material combine to resist acidification.

The extensive change in podsol properties under the influence of precipitation with pH=2.5 began the first year of watering. In the brown forest soil change was observed only after two relative experimental years. At the same time during the full term of the experiment and under the influence of extreme acid load 92% of exchangable K^+ was carried out, its reaction decreased per 1.3 units pf. pH, and the value of exchange acidity increased 6 times.

The influence of acid precipitation on the mold-gley soil was minimal. Only in the case of a strong proton load did the acidification process slightly affect the upper 5-cm layer of the mold horizon. In the lower 5 to 25 cm horizon the characteristic soil properties remained unaffected.

Thus, even within a single taiga landscape the resistance of different soils to the influence of acid precipitation is not the same. In soils sensitive to acidification a change in important properties may take place which affects the total condition and the productivity of the phytocenoses, while in stable soils only insignificant shifts in environment parameters were observed that have no negative ecological consequences.

INDICATION OF INDUSTRIAL POLLUTION BY DENDROCHRONOLOGICAL METHODS

A.P. Ivshin
Institute of Forestry, Ural Division, Russian Academy of Sciences, Yekaterinburg

Investigations were conducted between 1988 and 1990 with the aim of studying the reaction of trees to industrial pollution. Dendrochronological methods were used which give estimates of the increments of annual growth in a large number of trees and within broad regions. The main parameters observed were changes in indices of the width of annual growth rings in trees and temperatures in these regions.

The studies were conducted in areas north-east and south-east from Norilsk. In the north-eastern direction from Norilsk timber stands were studied in the region of the Norilsk River and the town of Talnakha, the western part of Lama Lake and in the middle course of the Mikchanda River. In the south-eastern direction the investigations were carried out in the western part of Lake Keta, along the Rivers Tukalanda, Kulyumbe and Severnaya. Larch was chosen as the main object of study. In the study area it is represented by different transitional forms from Siberian larch (*Larix sibirica Ldb.*) to *Larix daurica Turez.* and is the main forest-forming species. Siberian spruce (*Picea abovata Ldb.*) which, as a rule, is not the main forest-forming species was chosen to compare increments of annual growth with larch.

Ten dendrograms were obtained. The corridor method was used for exclusion of age trend. Following that, calibration was carried out for each timber-growth ring chronology with average monthly temperatures (beginning from August last year to July this year) in the period from 1901 to 1960. Relationships were estaablished by multiple linear regression. The independent variables were the average monthly temperatures and the dependent variables were the growth ring indices of increments. The stability of relationships in time was checked alternatively by use of a half time interval for the period of calibration. Then the prediction for the second calibration period and estimation of accuracy of such a prediction was done. A significant and reliable connection was established in all the cases. With the help of established equations and using present-day climatic data the increment of annual growth for the period from 1961 to 1986 to 1988 was predicted. The predicted and actual indices of growth during these time intervals were then compared to find out whether the difference was fundamental or not. In most cases the t-tests showed the difference between average values of predicted and actual growth.

The null hypothesis was taken only for the southern-most test area situated 320 km from Norilsk. During the test period several cases were noted when co-variation between actual and predicted growth was insufficient. This refers to all the test areas where visual signs of disturbances and increased tree fall were present. In most cases a considerable decrease in co-variation for 50% and less was observed when compared with the calibration period.

As a result of these investigations, anomalies in tree growth (increments) within large territories were found in trees of timber-stands where visual signs of disturbance (pollution) were present, as well as, in trees of healthy timber-stands. When differences exist between average values of actual and predicted increments, the connection with climate is decreased.

INFLUENCE OF OIL POLLUTION ON FOREST FLOOR PLANT COVER OF TAIGA FORESTS IN THE MIDDLE COURSE OF THE OB

M.N. Kazantseva
Tyumen Forest Experimental Station, Tyumen

Studies were conducted over 4 years (1987 to 1990) in the regions of intensive oil extraction in the middle course of the Ob. Over 40 test areas were placed (set out) on sites with different degrees of pollution. The degree was determined from oil-product concentration in woodland litter: weak (up to 10%), average (from 10 to 40%) and heavy (over 40%).

The forest floor plant cover is the most sensitive element of the taiga phytocenosis to pollution. In the case of oil getting on soil surface it first influences are in the above ground plant organs. Upon penetrating the soil, oil concentration decreases sharply from one soil horizon to the next making up only 0.8% (compared to the litter) at a depth of 15 to 20 cm in loamy soils. Thus the root system of herbs and shrubs which is almost completely concentrated in the upper 10 cm soil layer is the most greatly influenced.

During the very first year oil pollution plant death is at a maximum. The beginning and duration of its recovery depend on the degree of pollution. One of the earliest and most clear characteristics reflecting oil influence on forest floor vegetation is its above ground biomass expressed as a percentage of a control. This index steadily decreases with the increase in oil concentration in soil ($r = 0.54 \pm 0.14$; $r = 0.66 \pm 0.12$; with $P < 0.001$). Biological productivity of plants decreases sharply. Biomass of the above ground part of the forest floor vegetation decreases ($r = 0.62 \pm 0.12$ with $P < 0.05$; $r = 0.89 \pm 0.12$ with $P < 0.001$). At the average degree of pollution biomass is only 6.6% while at sites with heavy pollution it amounts to only 1.3% of that in control. Species diversity decreases ($r = 0.56 \pm 0.12$; $r = 0.60 \pm 0.12$ with $P < 0.001$). At this point the composition and correlation of species is changed. Some of them completely die out or are represented on the polluted area by a single remaining specimen. At the same time others (as a rule one or several species) not only remain in significant quantity, but at the high levels of pollution may even increase in number and begin to play a dominant role in the community. The Simpson (dominate) index naturally increases as oil pollution in the soil increases. At the high degree of pollution it may exceed the dominant index for clean areas by 2 times. The appearance of new species for a given community on the oil polluted sites was determined.

In estimating the effect of oil pollution on living forest floor vegetation, the duration of vegetation contact with the volatile components of the oil must be taken into account. These

toxic components are effective for only a short time after the oil spill. The heavy fractions of the oil which remain for a long time are less toxic. That is why on the places of old oil spills one can observe the reestablishment of herbaceous plants at greater abundance than on the newly polluted sites.

A COMPARISON OF LOCAL GRASSES WITH THOSE FROM ADJACENT AREAS UNDER THE CONDITIONS OF DISTURBANCE RECULTIVATION IN THE FOREST-TUNDRA ZONE

A.F. Khusainov
State University, Ufa

At present more and more disturbed areas appear, even bare areas, the result of intensive development of Northern regions. Thus, the problem of developing effective methods of biological recultivation is coming to the fore.

The aim of this study was to compare the practicality of using local wild grasses and those growing in adjacent regions for the recultivation of disturbed lands in the forest-tundra zone. The experiment was begun in the autumn of 1987. Four kinds of grass mixtures were sown; some of them belonging to local species, such as *Deschampsia sukatschewii*, *Poa alpigena*, *Calamagrostis lapponica*, and *Festuca ovina*. Others such as *Festuca pratense*, *Poa pratense*, *Elitrigia repens*, *Bromopsis intermis*, and *Phleum pratense* were from the adjacent regions. Both grass mixtures were sown in 4 variations: 1) with peat (50 t/ha); 2) with mineral fertilizer ($N_{30}P_{30}K_{30}$ - mineral fertilizers); 3) with peat-mineral fertilization (peat - 50 t/ha, mineral fertilizers $N_{30}P_{30}K_{30}$); and 4) controls. The variants were repeated four times. The size of the plot was 12.5 m^2. The results of the experiment are presented in Table 1.

TABLE 1

Comparison Of Project Covering In Percent (numerator) And The Grade Of Sod-Formation (denominator) According To The Experimental Format

Phytocenotic Variant	Edaphytic Variant	1988	1989	1990
1) Local Species	K potassium	5/0	20/5	30/7
	Peat	10/0	30/10	40/15
	Mineral fertilizer	--	30/5	45/10
	Peat + mineral fertilizer	--	50/30	90/55
2) Species from other regions	K potassium	0	1/0	2/0
	Peat	1/0	2/0	$3^+/0$
	Mineral fertilizer	--	$3^+/0$	$7^+/0$
	Peat + mineral fertilizer	--	$10^+/0$	$15^+/0$
+ covering formed as a result of the introduction of local flora				

Plots sown with local grasses showed an increased in standing crop growth. The majority of plants achieved their generative phase and this provided the seed bank for a further increase in sod formation.

The poor showing of meadow grasses from other regions can be explained by the ecological difference in soil-climatic conditions. Meadow grasses require the application of high dozes of mineral fertilizers and chemical modification necessary for neutralization of acid soils. This measure does not, however, guarantee the crop will not freeze out. At the same time changes in eudophitic (soil air quality) conditions after neutralization and eutrophication make it difficult or impossible to recultivate natural vegetation.

The use of local grasses for the purpose of recultivation does not require chemical melioration and decrease the amount of mineral fertilizers needed. A sod over of up to 50% is formed in the 2nd and 3rd years. To provide seed material for the purpose of biological recultivation it is necessary to organize farms specializing in growing seeds.

THE CONDITION OF THE FORESTS IN THE ZONE INFLUENCED BY THE NORILSK MINING-METALLURGICAL COMBINE

A.P. Laletin
Institute of Forest and Timber, Siberian Division, Russian Academy of Sciences, Krasnoyarsk

In the vicinity of the Norilsk forest an investigation is being made regarding the technogenic effects of the Norilsk Mining-Metallurgical Combine (NMMC). According to a report of "A survey of the State of the Natural Environment of the USSR" (1990) discharges of SO_2 from the NMMC in 1989 amounted to 2.23 million tons (13%) of that of the entire USSR). The NMMC is situated in the tundra forest zone. The thinly treed, predominately larch forest is on frozen ground and is confined to the river valleys which are often marshy. Massive destruction of the forests around Norilsk began in 1968. In 1976, the overall area of damaged forest land amounted to 339,000 ha and in 1986, this had reached 545,000 ha; i.e. over a 10-year period there was an increase of 1.6 times. During the same period the area of dead forests (the amount of dead and dried-out trees amounted to over 80% of the total) having increased 7 times (Grigoriev, 1991).

For the study of the influence of the NMMC on the forest biocenoses, a geobotanic report was made of the areas to the north of Norilsk (along the Norilsk-Talnakh highway) at various distances from NMMC. Of those plant studied, those in the very best shape were found to abe larch and shrub-birch, situated in the vicinity of Talnakh, approximately 40 km from the NMMC. This site has a moderate degree of damage with a plant density of 0.3. The felled timber, bushy undergrowth and the grassy undergrowth were found to be in quite normal condition. No evident signs of distress from technogenic influences were noted at

this level. Aqueous plants dominate the grassy undergrowth level, spots of dead bushy lichen were noted which, evidently, died under the influence of the NMMC discharges. At other investigated sites, even traces of the existence of lichens were not noted. T.M. Vlasova (1987) notes that at a distance of 50 km from the NMMC, it was found that in the lichens there was an increase in the nickel content of 3.5 times, and copper 15 times in comparison with control samples.

There is a sparsely treed area of larch and scrub-birch, that has been severely damaged where plant density does not even reach 0.1. It is situated approximately 20 km to the north of the NMMC. There one encounters an occasional live, but very distressed, larch, and many dried-out larches are noted. In the grassy under growth level, as in the former site, aqueous plants dominate; one occasionally finds meadow horse-tail shoots and horse-tail reeds, but field horse-tail is non-existent.

There are some sites with dried-out larches, located some 8 to 10 km to the north of the NMMC which have suffered very serious damage. The trees are all completely dead. At the grassy undergrowth level meadow horsetail dominates totally, and to a lesser extent there are horsetail reeds and field horsetail. Obviously, the wide proliferation of horsetail results from the technogenic destruction of the indigenous type of forest and indicates the increase in soil acidity. The aqueous plants and other forms of undergrowth (cranberry and blackberry) are not abundant, but on their leaves one often finds manifestations of chlorosis and necrosis.

From the results obtained one must conclude that the NMMC renders a large negative influence on the forest located to its north for a distance of about 40 km.

BIOLOGICAL PROPERTIES OF BIRCH SEEDS FORMED IN EXTREME CONDITIONS OF INDUSTRIAL POLLUTION

A.K. Makhnev and O.V. Makhneva
Institute of Forest, Ural Division, Russian Academy of Sciences, Yekaterinburg

Under conditions of technogenic pollution the tolerance of plant communities and monospecific populations, including forest-forming trees, depends on the reproductive capacity of the plants which, to a large degree, is determined by the biological properties of seeds. In this regard we studied the seeds of white birch and warty birch which grow successfully in the impact zones of the Middle-Urals copper-smelting plant and the Polevsk cryolite plant. The local birch-forests from field-protective belts. Even-aged birch-forests from the town plantations (Yekaterinburg) were used as controls. On each plot seeds were gathered from 50 trees (25 for each species).

In 1990 the birch in the middle-Urals had good seed production, but the quality turned out to be comparatively low due to damage by the birch-bug. This pest was practically absent

on the most heavily polluted plot by the Middle-Urals copper smelting plant, and in the town plantings. The inhibitory effect of phytotoxicants acted on the degree of microflora development in seed germination. Thus, for example, seeds produced under conditions of the Middle-Urals copper-smelting plant had a germination index 4-times lower than in seeds in field-protective belt (control).

It was shown that in birch seed germination under different temperature regimes all the samples had a wide range of germination temperatures (within the limits of 15-39°C). The range of optimal temperature in warty birch is broader than that of white birch and includes the maximal extreme regime -39°C, although the energy of seed germination at that temperature is lower than in other optimal temperature regimes. The time necessary for the beginning of germination was the same for all the seeds tested. Thus, the temperature indices for seeds of white birch, independent of conditions under which they were produced, practically do not differ. On the other hand, the index characterizing the mass of seeds, undergoes considerable changes over the pollution level gradient. In warty birch the most light seeds, 124 mg (1000 pieces), formed in impact zones of the Middle-Urals copper-smelting plant and 148 mg in the impact zone of the Polevsk cryolite plant, while in the town plantings this index is 194 mg. The average laboratory germinating capacity of seeds on all the plots ranged from 50 to 65%.

The anomaly frequency observed in germinating birch seeds was found to be quite low: polyembryos within the range 0.0001 to 0.0007%, primary seed-lobe appearance 0.005 to 0.0025%. At the same time the polyembryo frequency in germinating seeds in both white birch species was at a maximum in the presence of releases of fluorine compounds (Polevsk cryolite plant). The frequency of germs with primary seed-lobe appearance was also at a maximum under the level of pollution conditions of the Middle-Urals copper-smelting plant and Polevsk cryolite plant.

On the whole the materials of our investigation show that for the main indices, germinating capacity, germination energy and thermic properties - the seeds of white birch species, under consideration of heavy industrial pollution (in our case: aerial-technogenic), are potentially capable of providing for self-restoration of populations. The presence of increased anomaly frequencies is evidence of the possibility of undesirable genopool transformation of corresponding populations.

SOIL-CHEMICAL MONITORING OF THE NORTHERN LANDS

M.S. Malinina and T. Obukhovskaya
Moscow State University, Moscow

Monitoring of soil chemistry has disclosed unfavorable changes in the various components of the biogenocenosis that are the result of human activity. This has a special meaning for the northern territories. The ecosystems of the North are very vulnerable and can be easily

destroyed by exploration activities because they are not stable and have little buffering capacity for pollutants. The changes induced in such ecosystems are most evident in areas that are affected by anthropogenic influence. Such regions serve as the model for further development of the territory.

In the initial stages of the soil-chemical monitoring a large number of indicators should be considered, that may help to determine the main trends for the given ecosystem. With further development of monitoring only the most informative ones that relate to the known sources of pollution can be considered.

As a base for conducting the soil-chemical monitoring Velikiy Island in the state preserve of Kandalahsa was chosen. The main sources of pollution of the Kola Peninsula, such as the industrial complex "Apatity", Pechenega Nickel and the alluminium plant at Kandalahsa, are situated at a significant distance from the island. The pollution produced by these enterprises is composed of heavy metals. The negative influence of acid precipitation on the ecosystems includes the mobilization of several elements in the soil, which are toxic to the vegetation. The main burden of the gas and dust exhaust from the industrial complexes is experienced by the surface soil layer and upper horizons of the soils. Alluvial-iron-humus black-ash soils dominate the soil cover on Velikiy Island. The upper organic horizons of these soils have a large absorption capacity and are able to absorb and retain significant amounts of heavy metals. There was a higher content of nickel, copper, zinc and manganese discovered in the upper fermentative layer compared to the black-ash soil horizon. The accumulation of these elements, evidently, takes place in a natural biogenic way and is not connected with the pollution in the area.

More meaningful indicators in monitoring of pollution are the content of movable forms of metals which are determined from various extracts. It is however, necessary to take into account the significant variability of these indicators, as they reflect the different types of a landscape (alluvial, colluvial or accumulative [non-transported]). For instance, the movable zinc content (extract 1M KCI) ranges in the upper layer of soil from 17 to 20% in the accumulated landscape to 44 to 58% in the transit landscapes.

The resistance of the soils to the pollution also can be characterized by there buffering capacity relative to the heavy metals. This can be represented as the ratio Q/J, where Q is a factor of intensiveness (concentration of the element in the solution in balance with 1M KCI), and J - a factor of capacity (can be found in the series of consistent extracts 1M KCI and it can show the storage of movable heavy metals). Values for the buffering capacity of the soils under investigation are low for the upper layer. It is almost two times higher in the peat-humic horizons of the soils of the accumulative landscapes. Variability of this indicator is never more than 25% even for soils of the transit landscapes. In choosing the controlling index, preference should be given to the indicators with lower degree of variability.

AN ESTIMATION OF THE GEOCHEMICAL TRANSFORMATION OF SOIL IN GAS-CONDENSATE FIELDS ON YAMAL PENINSULA

D.V. Moskovchenko
Institute of Problems of the Development of the North, Siberian Division, Russian Academy of Sciences, Tyumen

An understanding of the chemical properties of soils and soil-materials of gas-condensate fields in the North is a necessary condition for successful recultivation of disturbed lands.

The study of the geochemical properties of soils and the extent of their technogenic transformation was carried out in the Bovanenkovo and Kharasavey fields. The micromolecular composition of soils of undisturbed and technogenic areas was carried out by semi-quantitative spectral analysis. Together with a determination of the general agro-chemical properties of the soil. Two types of areas were singled out according to the character and the degree of chemical pollution.

The first type is characteristic of areas directly adjoining the individual wells. As a rule, the surface of such areas is completely destroyed. The upper peat soil horizon is removed or mixed with the lower gley horizon. Drilling fluids, fuel and lubricating materials are spilled everywhere; scrap-iron, equipment remains etc. are scattered all over. In soils of these areas barium and strontium concentrations are 7 times that of background values. Barium and strontium are in the composition of minerals used in preparing drilling fluids. Other pollutant elements are lead, zinc and tin. Their concentrations are 1.5 to 4.6 times higher than background. The degree of pollution decreases with distance from the well. Thinly dispersed clay-powder, included in the drilling fluids, plays the role of an oxidizer changing pH of the upper soil horizon from 4.5 to 5.0 to 7.0 to 8.5 The quantity of humus material decreases considerably as well.

The second type is characteristic of areas of workers settlements and scientific stations (bases). Here the influence caused by technological processes accompanying drilling works is absent, but exhaust gases, the products of hydrocarbon combustion in flares, and fuel and lubricant spills play the main role in pollution.

Soil microelement composition is characterized by an impoverishment in some biologically related elements, such as manganese and cobalt. This can be accounted for by the disturbance and partial removal of the upper organogenic soil horizon(s). Lead, copper, vanadium and barium, which are related to technogenic sources are 1.5 to 3 times greater in soils of disturbed areas than in background or undisturbed areas.

Information of the geochemical impact on soils in gas-condensate fields should be considered when conducting recultivation programs. The content of such microelements as copper, lead, zinc and strontium in soils around drill sites increases the upper threshold boundary determined by Kovalshy and Andrianova (1970). Thus, in recultivation on these

sites it is necessary to consider the introduction of peat crumbs to reduce the relative concentration of pollutant elements, as well as, to increase of the content of organic matter and return acidity of the upper soil horizon to the background level.

RESISTANCE OF PODSOLIC SOILS OF THE NORTH TO CHEMICAL POLLUTION

G.V. Motuzova
State University, Moscow

Any increase in the regions of economic or agricultural use should be accompanied by a study of resistance of these ecosystems to anthropogenic influence. The danger of pollution by metals is very high. As is known, the extent and composition of pollutants is determined by technogenic factors and their transformation in the environment proceeds according to natural laws. The natural buffering capacity of the soil provides for fixation of pollutants and limits their migration in the landscape and their transfer into mediums adjacent to the soil.

The soil is capable of resisting pollution because of the composition of the different compounds that it includes. Among the compounds related to primary weathering and soil formation that are stable under anthropogenic influences. Also, there are compounds present which react to temperature fluctuations, humidity and microbiological activity. The resistance (stability) of the soil to chemical pollution is the result of its slow response to change under external influence and is related to the first group of compounds of chemical elements (metals). The soil stability that results from the capability of there compounds to react on the external influence and restore their condition is related to a group of dynamically changing, movable compounds.

Resistance of the soil to pollution is characterized by the interrelationship of the above groups of compounds of chemical elements in soils. The greater quantity of pollutants the soil is capable of receiving without greatly changing the content of their movable compounds, the greater is its resistance to pollution and the more it is able to protect biotic and abiotic components of ecosystem from pollution.

Among the moveable pollutant compounds that were identified are compounds within the soil solution and in the solid phase that were in dynamic balance. Those in soil solution are considered actual or real pollution, those in the solid phase are considered as potential pollutants. This relationship determines the soils ability to resist pollution. In highly resistant soils there is a lower level of actual pollution in the soil as well as the ecosystem.

Podsolic soils of the North display resistance to pollution by metals of different types. Soils with thick litter horizons have a high resistance to metal pollution because these can absorb large quantities of metals, but they can release them easily. Illuvial-iron-humus horizons have high resistance/stability to both soil solution and solid phase metals. Long lasting

fixation of pollutants in these horizons results in a decrease of actual soil pollution. Resistance/stability of podsolic horizons is very low. The structure and functioning of compounds of chemical elements in the profile of podsolic soils considerably influences the pollution of soils and ecosystems of the North as a whole.

THE RATE OF BIODESTRUCTION OF ORGANIC REMAINS IN THE FOREST TUNDRA

V.A. Mukhin
Institute of Ecology of Plants and Animals, Ural Division, Russian Academy of Sciences, Yekaterinburg

Biological turnover in hypoarctic ecosystems is characterized as slow (Nikonov, 1985). This suggests low rates of biological production and correspondingly, in the intensity and rate of biodestructive processes. Many years of observations on biological decomposition of branch fall of *Larix sibirica*, *Picea obovata*, *Betula pubescens* and shoots of *Betula nana* and *Salix sp.* has confirmed the extremely low intensity of these processes in forest-tundra.

In the southern shrub tundra the shoots of *B. nana* and *Salix sp.* are mineralized at a rate of 3.7 to 3.9% a year. Their complete biological decomposition takes two years. The same rate of biodestruction of branch fall of *L. sibirica*, *P. obovata* is found in the thin forest-tundra. Yearly mineralization ranges between 3.4 to 3.7% and decomposition is complete in 22 to 24 years. Branch decomposition of *B. pubescens* is a bit faster, 4.2% a year, with complete decomposition in 19 years. It should be noted that the above values characterize the rate of biological decomposition under rather favorable ecological conditions for biotopes of the forest-tundra on well warmed and well drained slopes. Under other conditions we may expect lower rates of biodestruction of organic remains.

The data not only confirm the slow down of biological turnover of forest-tundra and tundra ecosystems, but also indicate their limited potential for self-purification and their low resistance to organic pollution.

THE INFLUENCE OF OIL POLLUTION ON THE BENTHOS OF RIVERS IN THE SURGUT REGION

E.A. Novikova
State University, St. Petersburg

These studies were conducted on a tributary of the Vatyegan River 80 km east of the town of Kogalym and on four rivers to the northwest of Surgut during summer seasons of 1989 and 1990.

In the tributary of the Vatyegan River benthos was collected at 3 points: 1) a clean area above the place of oil discharge into the river; 2) 100 m down stream from the point of oil discharge and 3) a point 3 km from point 2 in the lower river course. At point 1, fifteen aquatic groups of invertebrates were discovered with a density of 2172 specimens per m^2. At point 2, no benthic organisms were found. At point 3, in the area with remains of oil pollution, 3 species representing aquatic groups were discovered (*Nematoda*, *Oligochaeta*, *Chironomidae*) with a total number of 34 individuals per m^2. Analogous data on phytoplankton from these 3 points are available.

The clean area (point 1) of the river, using the system of indicator-organisms may be referred to as oligo-beta-mesosaprobic with a Vudivissa biotic index of eleven. At the point (2) of heavy oil-pollution the conditions are at least polysaprobic. The water at point 3 can be referred to alpha-meso-poly-saprobic with a biotic index of three.

The rivers in the environs of Surgut are characterized by a great variety of chemical pollutions. The Milton-Yaun River may be considered to have relatively little in the way of oil products: there is neither a thin cover of oil on the water surface or on the ground (bed). The oil-product contents in water amount to 0.27 mg per l, chlorides 10.65 mg per liter. Forty species of invertebrates from 19 aquatic groups with a total number of 1415 to 3042 specimens per m^2 were discovered in the benthos. Larvae of *Chironomidae* and *Oligochaeta* dominated and there were numerous larvae of insects: mayflies, stoneflies and caddis-flies. The Vachim-Yaun, Mokhovaya and Malaya Chernaya Rivers are considered to have average oil pollution with a thin oil cover on water surface and on the bed.

Hydro-chemical characteristics of each river are specific. The Vachim-Yaun River has a pH of 4.2, increased concentrations of ion-sulfate (104.8 mg.1 per l), sodium ion (46.4 mg.l per 1) and organics. In the benthos 9 aquatic groups were identified with a total number of 263 specimen per m^2. The water of Mokhovaya River has a pH of 6.8, increased concentrations of chlorine ions (134.4 mg.l per 1) and sodium ions (82.4 mg.l per 1). In the benthos invertebrates from 14 groups were found with a total number of 425 specimen per m^2, *Oligochaeta* and *Chironomidae* dominated (134 specimen per m^2). Water in the Malaya Chernaya River has a pH of 5.2, increased content of chlorine and sodium ions (64.5 and 37.5 mgs.l per 1) and there are many suspended particles in water due to hydro-alluvial activity. In the benthos, 13 aquatic groups of invertebrates were found. Although the total number is high (2683 specimen per m^2) represents mostly one species of *Chironomidae*, 75% of the total number. The number of other invertebrates is not high; 650 specimen per m^2.

The Bystrinka River is considered very polluted with a considerable quantity of oil observed on the water surface, on the shores and on the bottom. The oil content in water is 0.46 mg.l per 1. In the benthos 9 aquatic groups were discovered with a total number of 5188 specimens per m^2. *Oligochaeta* and *Chironomidae* dominated (82.1% and 15.1% of the total). The other species were represented by 129 specimen per m^2.

In heavy oil pollution conditions, complete dehydration of invertebrates living on bottom may take place. when lesser quantities of oil are in the water the benthos reacts by decrease in species diversity and is dominated by some resistant species, often high in number. Under conditions of relatively low contents of oil-products in water, but in combination with chemical and mechanical pollution the species diversity of the benthos decreases as do their number.

CONTAMINATION OF THE ENVIRONMENT IN THE LAPLAND PRESERVE

S.G. Paramonov and Yu.A. Buivolov
Institute of Global Climate and Ecology of Goskomgidromet, Russian Academy of Sciences, Moscow

The problem of the impact of pollutants from the city of Monchegorsk on the ecosystems of the Lapland preserve has existed for the last decade. Vegetation along the Murmansk highway from Monchegorsk to the Chun Lake has greatly degraded. In July-August 1990 a field study of the territory of the Lapland biospheric preserve was carried out with the purpose of defining the contamination level of the environment and determining the possibility of the creation of a station for monitoring the complex background (SCBM) in the area of the preserve.

Measurements have shown that levels of air pollution with sulfates and polycyclic aromatic hydrocarbons (PAH) were, with reference to the background level, at relatively constant concentration during the observation period. Average values for the concentrations of heavy metals were not higher than in the background regions of Russia but, on certain days the average values have been exceeded by 10 to 30 times. a number of ingredients such as cadmium, copper, zinc, nickel and sulfates correlate among themselves and the correlation coefficient is essentially higher than data commonly observed at the background stations. This leads to a conclusion about the existence of a common source of the above-mentioned pollutants.

The concentration of lead and cadmium is 2 to 4 times higher in the precipitation than at the observed background (ETC) stations. Mercury concentration is 10 to 15 times higher than the background levels, established in the eastern parts of Europe. Data on PAH do not differ from similar measurements in other regions.

The results of the identification of chlororganic pesticides, lead, cadmium and zinc in surface waters are within the background limits, defined by the majority of stations (and are), characteristic for large water flows of the Volga basin. High concentrations of mercury in every sample are higher than the allowed limits.

Concentrations of lead, cadmium and zinc in green mosses (*Pleurozium schreberi*) and soil samples are not different even from samples on widely separated sites (over 200 km). The

concentration of these elements (in samples) reflects the existing regional level and is not related to local sources. The greatest difference among sites is in samples of copper and nickel (25 times). In most samples of moss the concentration of copper and nickel is higher than at the ETC stations. Sites with a high content of nickel and copper in the samples are in the traverse (pathway) of pollution from the complex "Severonickel". Differences in the concentration of PAH are also meaningful (5 to 6 times) and do not exceed the median observed at the background stations (3).

On the basis of the mathematical modeling, estimations of pollution by metals from the "Severonickel" complex have been carried out. During a year about 3 thousand mt. of copper and 3.7 thousand mt. of nickel pollute the atmosphere. Calculations, which were carried out with average long-term parameters for the atmospheric transition, have shown that in the area of the central (recording) station of the preserve about 70 ml. per g per m^2 of copper and 140 ml. per g per m^2 of nickel precipitate during a year. That is the level of the annual anthropogenic input and is commensurate with the background stock in the upper 5 cm layer of the soil.

The study of the possibility for the establishment of a SCBM has shown that observations of the background pollution of atmosphere are possible at the transition of southern and south-west compass points which predominate in the cold period. At that time streams of pollutants from ETC and West Europe will be observed. In the warm period the station will work in the regime of subtorch observations. The presence on the territory of the preserve of sites with various degrees of the anthropogenic impact is of interest for the research on the problem of dose- effect.

FOREST RECULTIVATION OF DISTURBED SOILS IN THE ZONE OF NORTHERN TAIGA IN THE KOMI REPUBLIC

V.I. Parfenuk and A.P. "Nauka" Usinsk

From an ecological point of view, the European north-east of Russia, is quite a peculiar region. Here the ecosystems are not stable and are easily disturbed and the natural processes of recultivation are extremely slow due to severe climatic conditions. When natural components of these ecosystems are subjected to technogenic influence, the results can be ecologically unfavorable and sometimes irreversible.

In the zone of industrial activity of the oil and gas administration "Komitermneft" disturbed lands must be planted with protective forest stands and other plantings. The aim of this work is recultivation of native tree and grass vegetation.

Recultivation of lands disturbed in the process of research, drilling and exploitation, storage, preparation and transportation of oil was carried out between 1987 and 1990. The work was conducted in the following way: (the extent of) disturbed soils was determined and then

protecting forest stands and artificial grass covers were formed. In the process of recultivation of the disturbed soils Scotch pine (*Pinus silvestris*) and Siberian spruce (*Picea obovata*) taken from the adjacent phytocenoses were used as planting material. On technogenically disturbed areas with poor sandy soils, seedlings of Scotch pine and willow (*Salix ssp.*) cuttings were planted. To form artificial phytocenoses pure and mixed seedings of perennial grasses, such as meadow fescue (*Festuca pratensis*), timothy (*Phleum pratense*) and a number of agricultural varieties such as pea (*Leguminosae*) and oats (*Gramineae*) were used.

The formation of protecting forest stands and artificial phytocenoses took place on soils disturbed in the course of building industrial facilities and on soil contaminated by oil or drilling solutions. The efficiency of different kinds of recultivation (forest, biological and agricultural) is defined by the degree of acclimatization of woody plants and the development of covers of grass and agricultural plants (Table 1).

TABLE 1

Acclimation of Woody Plants and the Field Growth of Grasses in Relation to the Mode of Recultivation

Location of the Plot	Size of Plot (ha)	Land Category	Species of Planting Material	Acclimation Field Growth
1) Oil-field development 2, drill plot, settlement 89.	2.00	Middle-sized drainage. Oil spots.	1) Seedlings of woody plants with some soil on the roots. 2) Sowing Timothy grass (*Phleum pratense*).	1) 45% 2) No
2) Oil-field development.	6.00	Technogenic area.	1) Planting of Siberian spruce seedlings. 2) Planting of willow cuttings.	1) 15% 2) 75%
3) Oil-development I, the region of drill plot settlement 100	2.10	Technogenic area (local spots polluted by oil and drilling liquids).	1) Planting of Siberian spruce seedlings. 2) Planting of willow cuttings. 3) Meadow fescue grass (*Fescuta pratensis*). 4) Oats-pea mixture.	1) 32% 2) 10% 3) No 4) No
4) Plot PTV-2 5) Plot BPO-1	0.03 0.50	Soils damaged at the completion of construction.	1) Mixture of oats and meadow fescue grass. 2) Meadow fescue grass.	1) 52% 2) 28%

WATER RECOVERY: A NEW DIRECTION FOR HYDROBIOLOGICAL RESOURCES

V.V. Rusanov[1)] and N.M. Mingazova[2)]
[1)]Laboratory of Nature Protection, Mining Institute, Yekatherinburg
[2)]Chair of Nature Protection, State University, Kazan

Whereas theoretical and practical questions of terrain reclamation have been widely studied, the problem of the recovery of waters disturbed during mining and other activities remains to be studied. There is an urgent need to develop a new direction in preservation and rational use of water bodies.

The aim of water recovery is to restore the productive processes in water bodies, subjected to anthropogenic impact and to develop and implement measures of preservation of species and to quantify the hydrobionts and their habitat both before and during construction activities.

The objects of water recovery focuses on: rivers and parts of rivers subjected to mining and related technical development, technogenic waters, reservoirs, sewage ponds, underwater extractions (chemical and physical), river beds containing toxic substances and the river bank zone.

Water recovery may be subdivided into two elements; chemical and physical recovery of mine waters, and biological or hydrobiological recovery. Hydrobiological recovery involves a complex of fish-breeding measures, as well as the introduction and acclimatization of valuable species.

In water recovery the following levels may be reached:

1. Full recovery of a river or its parts including hydrological parameters, granulometric composition of the river bed deposits, restoration of the initial species composition of hydrobionts and productivity of the biocenosis.
2. Partial recovery of the water body with continued hydrobiological self-restoration.
3. Partial recovery of the water body with the development of cultured fish-breeding.
4. Partial recovery to create a recreational landscape.

The level of recovery is fully defined during the development of ecological evaluations. Three stages are suggested: 1) At the first project or stage in which monitoring of biological objects is carried out, reserve or buffer zones are defined and nature protection measures are defined and the final level of recovery is planned. 2) The working stage in which hydrological conditions are created, opening the upper parts of the river. At this

stage spawning areas are restored, additional spawning canals are built and fish protection structures are set. 3) At this stage the planned level of recovery is reached.

STABILITY OF LAKE ECOSYSTEMS OF THE YAMAL PENINSULA AND THEIR TRANSFORMATION UNDER ANTHROPOGENIC IMPACT

N.V. Savchenko
ONIL Centrosoyuz, Novosibirsk

In order to estimate the present condition and direction of natural processes in the subarctic of Yamal, and to develop predictions of possible changes, it is necessary first, to study widely separated and vulnerable parts of natural ecosystems, and the processes that define the conditions of their existence. The results of our studies (1988 to 1990) have shown that lake eco-systems are important in such process studies and predictions.

The total number of lakes in the region is over 24,500. The cumulative area of their water surface is nearly 9,800 km^2, and their water volume is 33,400 km^3. The medium index of lakes (lake area to the total area) is 12.2 percent, and ranges between 0.5 and 88 percent over the peninsula. It exceeds the country index by 5.5 times.

At present, lakes are rather vulnerable ecosystems because, on one hand, owing to their hydrogeographic position they are natural collectors of water from surrounding watersheds and on the other hand, most areas of these water reservoirs are within the sphere of intensive economic development of the west Siberian Territorial Production Complex (TPC). The self-purification and self-restoration potential of each lake, together with the adjacent water watershed, is effective only if its ecosystem is not disturbed. In this situation, its stability is preserved.

Stability is the most important property, characterizing the quality of the environment and it allows scientific estimation of the limits of transformation of natural ecosystems of various sizes. It also permits forecasts or predictions and the development of measures for preventing unfavorable changes in them. However, at present there are no accepted theoretical and methodological investigations by which fast and reliable definitions of the functional-dynamic state of limnoecosystems can be made. To solve this problem the method of landscape-geochemical coefficients (water migration (Kv) and biological accumulation (Kb) together with migration-geochemical formulae (MGF) may be useful (Savchenko, 1988, 1989, 1990).

The MGF characterizes every lake and its adjacent watershed as a unique ecological system that presents a logical coupling of opposites, i.e. the transition and accumulation of substance and energy. If, in a formula, the sum of Kv and Kb is large (over one order), and the composition of the water and biogenic migrants is represented by the largest number of definite chemical elements, then the limnoecosystem will be the most dynamic and stable.

On the contrary, a MGF dominated either by biogenic materials (humic components) or by water migrants (soluble mineral components) it is a clear sign of disturbance of the stability of the limnoecosystem.

The application of this method permits the conclusion that at present, the limnoecosystems of areas of Kharasavey, Bovanenkovo and Novy Port are in an unstable condition. Here during gas prospecting caterpillar tractors that were used disturbed the soil and vegetation of lake watersheds over 40 to 100 percent of the area. This, in turn, caused an intensive mineralization of humus and transportation of many chemical elements into the lakes. Water movement of 26 elements exceeds their bioaccumulation by 1550-1800 times. The nutrient composition (nutritional composition) of lakes has changed correspondingly.

SOME PECULIARITIES IN RECULTIVATION OF OIL-POLLUTED AND DISTURBED TERRITORIES BASED ON THE EXAMPLE OF SURGUT PRIOBJE

O.M. Tereshenkov, H.A. Kutiev, E.N Popova, and K.A. Mamkaeva
State University, St. Petersburg

Since there exist many and varied kinds of pollution and disturbances on the lands in the region of oil production, the methods of ecological change and the manner of recultivation of these disturbed and polluted ecosystems should also be varied and scientifically supported.

The following are approaches to the study of oil polluted ecosystems: 1) the use of dated (time dependent) models with different levels of pollutant in both field and laboratory investigations. 2) The combination of long term field experiments with laboratory investigations that can give an effective evaluation of the existing methods of recultivation on disturbed and oil polluted land.

As a result of investigations carried out on the oil polluted ecosystems of Surgut Priobje, it can be stated that the process of oil pollution of soil has not resulted in any serious changes in the main chemical characteristics of the soil (with the exception of hydrolythic acidity - which shows significant changes with the increase of a pollutant concentration). There is however, a significant decrease in soil physical properties as a result of capillary blocking, especially in soils with heavy granulometric composition. This results in significant changes in their water and air regimes. The latter, alongside with toxicity of some oil fractions, is the main reason for the decrease in growth and death of higher plants. Oil pollution stimulates the development of saprophytic bacteria and increases the microbiological activity of the soils, especially if catalase activity is taken into account.

To compare the different methods for recultivation of oil polluted soils, investigations were conducted on dynamic models and chemical and spectrophotometric characteristics of soils

recultivated with the addition of peat or soil materials. In the course of our investigations we came to the conclusion that the area of pollution, in the majority of cases, extends beyond the territory directly polluted by black mineral oil. This resulted from transportation of the water soluble oil fraction in ground waters. It is of particular concern in peaty-boggy soils. The indicators of extended pollution are the vegetative communities and their state or condition. Even recultivated areas, ie. covered by peat or sand, continue to pollute adjacent areas as a result of the filtration of oil products through ground waters.

THE AFFECT OF TECHNOGENIC AIR POLLUTION ON ASSIMILATIVE APPARATUS OF CONIFERS IN THE FOREST-TUNDRA

N.S. Zavjalova, S.L. Menshikov and T.B. Srodnykh
Institute of Forestry, Ural Division, Russian Academy of Sciences, Yekatherinburg

Between 1986 and 1990, investigations were carried out on the territory of the Taimyr forest-station of the Turukhan forest farm which is in the zone (of influence) of the Norilsk Metallurgical Plant (NMP). The main component of the gaseous emissions from the plant was sulfuric anhydride (H_2SO_4) which comprised 96 to 98% of the total amount of gaseous emissions together with emissions of solid copper nickel, cobalt.

The major forest species in the region investigated are Siberian larch and spruce. Three permanent test-plots were set up in Siberian larch and Siberian spruce stands. Test-plot 5 was situated at the distance of 15 km from the Norilsk Metallurgical Plant; the vegetation is rather poor consisting of 76.9% of dead or dying larch trees and 33.8% dead or dying spruce. Test-plot 6 was situated at the distance of 30 km from the Metallurgical Plant; the vegetation there is debilitated; the percentage of dead and dying trees is 16.3% and 2.3% respectively. Test plot 35 (control) was situated at the distance of 150 km from the Metallurgical Plant where there are no visual signs of disturbances; dead and dying trees were 15.7 and 4.3% respectively. The following determinations were made on the test-plots: a taxonomic description of the tree-stands, estimation of their state of health, the rate of change in the needle tint, degree of defoliation, phenorhythm of larch and spruce, the content of pigments in the needle of these species and the peroxidase activity.

The visual estimation of the state of the stands in the zones with various technogenic loading showed that spruce was highly resistant. Four-years of experimental work with larch and spruce phenorhythm in stands badly disturbed by emissions (test-plot 5) and on debilitated test-plots (test-plot 6) showed that spruce had the same rhythm of phenological development on both the plots. Larch however, lagged behind in its phenological development by 2 to 4 days on test-plot 5 in comparison with test-plot 6. In addition the phase of autumn coloring of larch in the zone of great disturbance set in two weeks before it did in the zone of weak disturbance (plot 6).

The experimental work showed significant variations in the content of all the pigments in the larch of healthy but weakened stands: on test-plot 35 chlorophyll A showed a 30 to 40% increase; chlorophyll B an increase of 38 to 55% and carotenoids a 25 to 31% increase. The amount of pigments in various-aged spruce needles depended not only on the conditions of the location, but on the age of the needle. Young spruce needles showed a 38 to 55% decrease of chlorophyll A near the Metallurgic Plant. At the same time the needles of two to five year old trees on the stands with good and poor plants showed a 40 to 60% decrease of chlorophyll A. Chlorophyll B showed analogous changes. The trees (spruce) showed a larger content of carotenoid in the needles of the first and fifth years and also in the needles of the strong healthy stands.

In larch and spruce trees nearer to the Metallurgic Plant the activity of peroxidase in the needles increased. Thus in larch on test-plot 5 it was equal to 0.04 and on test-plots 6 and 35, to 0.25 and 0.18 of APO. Young needles of spruce in the weak stands showed a higher activity of peroxidase than on all other areas (by 3.7 and 20 times), two-year needles by 2.4 and 5.1 times and five-year needles 1.3 and 4.1 times.

In conclusion it can be noted that bad conditions for spruce stands in the zone of the Metallurgic Plant were reflected in a decrease in the phenological development, pigment content and an increase in peroxidase activity. The data can be used for diagnoses of disturbances from technogenic air pollution.

SECTION 2: BIOLOGICAL RECULTIVATION

INVESTIGATION OF THE BIOLOGY OF GRASSES FROM NORTHERN POPULATIONS ON DISTURBED LANDS

N.B. Andreeva and L.P. Turubanova
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

One of the main tasks of recultivation is the reconstruction of vegetative cover on disturbed areas. The formation of perennial grass communities (grassing) on areas of disturbed moss-lichen surface cover is most effective. In tundra the process of self grassing is rather unsure because of the small quantities of seeds in the soil (seed bank), because tundra seeds do not mature every year and only some % of them come from the adjacent areas. To form a stable secondary grass cover it is necessary to use seeds from local populations. Because of the local absence of necessary seeds we began to study the biology of different species in order to choose the best for recultivation.

On Yamal peninsula (Bovanenkovo) the experiment was started with the application of seeds obtained in the vicinity of the towns of Vorkuta and Labitnanga, as well as, seeds obtained from other investigators working with northern grass populations. The seeds were sown on July 2nd, 1989 at a rate of 100 seeds per m^2 in a 4-fold repetition.

In the year of sowing the most active branching was observed on red fescue grass (*Festuca rubra*), meadow foxtail (*Alopecurus pratensis*), Hungarian brome grass (*Bromus inermis*), lyme-grass (*Elymus*), meadow grass (*Poa pratensis*) "Dyrnos".

After wintering from the first year of the life-cycle to the second, meadow grass "Dyrnos" survived better than other plant species and by the middle of August (1990) formed a thick and high grass-stand (to 90 cm) with a thick bunch. Some bunches had up to 25 shoots.

On the second year of life, meadow foxtail (slough grass) showed 358 well developed generative shoots per 1 m^2 (Table 1). These plants achieved the phase of the beginning of heading, were rather tall (90 to 100 cm) and had a great number of generative shoots. However, none of the specimens under investigation produced mature seeds. In the second year of the life cycle Hungarian brome grass (*Bromus inermis*) and lyme-grass appeared to be in a depressed state. During the second vegetative period braids of wood-rush (*Juncaceal*, 44 specimens) appeared. The braids of bush grass (*Calamagrostis epigeios*), Arctagrostis and willow herb (*Chamaenerium angustifolium*) were not noticed.

Preliminary data from 2 years of observations show that meadow grass (*Poa pratensis*) "Dyrnos", meadow foxtail (*Alopecurus pratensis*), meadow foxtail (*reed*), slought grass, red fescue grass (*Fescuta rubra slought*) were most stable and they can be recommended for biorecultivation of disturbed lands in Yamal tundra.

In 1990 a series of experiments was started to work out technological process of biorecultivation. The experimental work includes tests with different kinds of fertilizers, different doses and rates of seeding. We are going to continue our experimental work including investigation of the problem of seed production of the recommended grasses.
In Table 1 below: * in the numerator - the number of generative shoots. In the denominator - the number of vegetative shoots. ** Means the number of shoots was not counted.

TABLE 1
BOVANENKOVO TEST SITE

Plant (local of seed origin)	The first year life-cycle 9.09.89		The second year of life-cycle 16.08.90	
	Number of shoots per 1 m^2	Height cm	Number of shoots per 1 m^2	Height cm
Poa pratensis "Dyrnosskii"	131	10	42*/1221	90*/44
Poa pratensis "Kircshinski"	50	1-2	0/256	0/25
Poa sp. (Labytnangi)	36	10	0/90	0/22
Alopecurus pratensis (Vorkuta)	117	12	20/773	97/54
Alopecurus arundinacea (Salehard)	246	20	47/575	106/78
Beckmahia eruciformis (Salehard)	68	10-18	358/349	98/39
Elymus sibiricus (Salehard)	91	10	0/153	51/45
Phalaris arundinacea (Komi Republic)	**	30-35	**	0/72
Bromopsis inermis (Komi Republic)	211	7	0/19	0/25
Festuca rubra (Yeketherinburg)	212	2-3	0/547	0/27
Arctophila fulva	90	3-5	0/146	0/35
Agropyron repens (Salehard)	45	1-2	**	2-15
Arctagrostis latifolia (Anadyr)	47	3-4	no shoots	

MICROFLORA OF OIL DEPOSITS IN THE KOMI REPUBLIC AND PERSPECTIVES OF THEIR APPLICATION IN BIOLOGICAL RECULTIVATION OF POLLUTED SOILS

G.K. Androsov
State University, Syktyvkar

Pollution of the biosphere by oil and oil products is so great that many species of water and soil organisms appear in danger of extinction. Taking into consideration the great number of oil deposits, oil pipelines and the development of new oil fields in the North of Russia it is possible to say that this region is in great danger of ecosystem disturbance.

Specialists in different scientific fields study methods of reclamation from oil pollution. The method of oil biodegradation is one of them. The main direction of such investigations lies in the field of microbiology. Information concerning the potential role of microbiota in oil biodegradation centers mainly on marine and fresh water microorganisms. There are a number of results that are encouraging for the use of prepositive forms in sea surface purification from oil pollution. However, in the application of microorganisms for clearing soil of oil pollution it is necessary to note that there are still more problems than achievement. There are practically no investigations on microbiota of oil deposits in the North nor, in the Komi Republic is there information concerning the distribution of microorganisms suitable for oil degradation.

Our investigation is the first attempt to analyze the composition of the microflora of oil deposits on the territory of the Komi Republic and also to distinguish ecological groups of microorganisms capable of degrading crude oil in the soil.

We managed to obtain 48 stocks or microorganisms of various taxonomic composition: *arthrobacteria, pseudomonades, sarcinas, streptomisetes, microbacteria*, and *candides*. In the experiments on biodegradation of oil hydrocarbon we found activity in such stocks as *Ps.putida*, *Mycobacterium smegmatis*, *actinomyces Sp.* and stocks of *Candida utilis* ferment. The facts provided show that oil degraders are ancient cosmopolitan formations. In the future much attention should be given first of all to the stock of *Pseudomonos* Species. In the bacteria of this species oxidoreductases can decompose a great number of molecules of hydrocarbon and aromatic compounds. In addition, the presence of genes defining these ferments in the plasmids, holds the promise of developing recombinant stocks through biotechnology; stocks which can grow on crude oil.

PREDICTION OF THE DIRECT DAMAGE TO THE VERTEBRAE POPULATION (BIRDS) OF THE EUROPEAN NORTH-EAST DURING THE CONSTRUCTION OF GAS-MAIN "YAMAL-WEST" PIPELINE

V.M. Anufriev and S.K. Kochanov
Institute of Biology, Komi Science Centre, Syktyvkar

Biological recovery should be understood not only as restoration of vegetation and soil but as a minimization of the damage to the animal world which plays an important role in the formation of the environment. Thus one estimation of the damage to animal population should be an important starting point for working-out measures for the restoration of the disturbed natural complexes.

The results of calculations on the damage to bird populations within the European North-East of Russia during the construction of the gas-main "Yamal-West" pipeline are given in Table 1. Evaluation data in 1985-1987, 1989-1990 were developed according to the method of Yu.S. Ravkin (1967) for the middle, northern and northernmost taiga and tundra subzones. Data on the bird population of the northern tundra were taken from literature (Mineyev, 1982, 1983; Yestafiev, 1986; Krivtsov, 1987). Direct impact is recorded as the difference in the amount of natural habitat allotted for construction and the actual transformed landscapes. Data on the correlation of these areas are taken from the technical-economic verification (report) of the "Yamal-West" gas-main. Evaluations on the indirect damage by hunting and recreation were not analyzed.

TABLE 1

Sum Stock Of Birds And Its Possible Change Along The Gas-Main Route "Yamal-West" (Sites North - 1,2,3)

Subzone, zone	Stock of species (number of birds)			
	Before construction		After construction	
	Total	On the temporarily allotted regions	Total	On the temporarily allotted regions
Middle taiga	25905	4620	24510	4050
Northern taiga	14465	2505	8933	1545
Northernmost taiga	15690	2330	6680	800
Forest tundra	21130	5460	10560	1130
Southern tundra	11920	2070	9180	350
Northern tundra	7080	1560	3770	150

The magnitude of the damage (in percent) on the gas-main route increases from southern regions to the northern ones. Thus in mid-taiga which has a group of southern bird species adapted to living in sparse and mosaic landscapes the decrease in their sum stock is minimal. In northern subzones of the forest zone and forest tundra the number of birds will decrease by 2-2.5 times. In tundra similar tendencies are found. In the subzone of southern tundra the stock decrease will not be so great since on the restoration areas birds of meadow-swamp complexes can settle while flying to the North through intrazonal landscapes. In the more severe subzone of northern tundras that species group (birds of meadow-swamp complexes) is not large. On the disturbed regions game and hunting species adapt themselves poorly.

In the North damage to especially protected species is notably higher. For example in the mid-taiga the habitat for golden eagle and sea eagle (Osprey) is taken for construction purposes. In the forest tundra four species will suffer damage. Construction of the gas-main on the northern tundra will result in the loss of about 25 protected species. Damage to bird population in forest and tundra zones increases. Compensation by invasion of the transformed (disturbed) areas cannot be considered adequate because large and valuable bird species loose their sites whereas small passerine species take over the disturbed territories. In settlements the main inhabitants are crows and others can be considered to be species that cause damage to natural complexes.

The research on the evaluation of damage to small vertebraes and amphibia coincide with estimation of data on bird population. Thus, we suggest that only in mid-taiga and southern tundra does natural inhabitation of the areas by animals satisfactorily compensate for damage. The main steps for decreasing damage in other forest and tundra zones should be an artificial increase of mosaic landscapes and in the northern tundra-protective measures such as allotted preserves and recreation zones.

BIOLOGICAL RECULTIVATION IN THE NORTH (THEORETICAL AND PRACTICAL PROBLEMS)

I.V. Archegova, N.P. Akulshina, and N.S. Kotelina
Institute of Biology, State University, Komi Science Center, Ural Division, Russian Academy of Sciences, Syktyvkar

As a result of a large-scale exploitation of mineral resources in the Far North, construction of oil and gas pipe lines, highways and other linear construction features there have occurred extensive violations of natural ecosystems. These violations become irreversible because of the destruction of the central structure of the ecosystem-vegetation community. This is accompanied by disturbance of the hydrothermal regime and erosion, which is developing on a vast scale and producing changes in the structure of the areas larger than those produced by technogenic activity alone.

Increased anthropogenic changes in nature in the North are mainly connected with certain peculiarities of its structure which is rather sensitive and vulnerable. Fundamentally it is the very weak links between the entire bio-complex and the mineral layer which is under severe temperature conditions thus the changes are especially strongly expressed in the relationship between vegetation and soil. The shallow, fertile organic accumulation layer is fully destroyed together with the vegetation community. This report considers some new aspects of the biological importance of soil that helps to understand the peculiarities of recultivation in the North. Its main task is the restoration of disturbed natural systems in the North that require new techniques and methods from those applied in the South of the country.

Well defined methodology and approaches in biological recultivation are important in the process of restoration of nature in the North. To prevent irreversible changes in nature and an increase in soil-erosional processes it is necessary to undertake reconstruction measures for nature that take in to account the peculiar conditions of the Far North. The methods of grassing of disturbed lands with the application of local plant populations is the central point in the biological recultivation in the North.

It is now the fourth decade of our observations of the first artificial meadow in tundra. Actually it is the first organized monitoring of a secondary biocenosis in East-European tundra and provides important data on which to base a theory of monitoring the development of secondary cultural ecosystems under extreme climatic conditions. It is possible to use local grasses to speed up the process of nature recovery, but it can be effective only with the use of frost resistant grass seeds produced in the same northern conditions. Seed production of meadow grass (*Poa pratensis*) and meadow foxtail (*Alopecurus pratensis*) in the zone of forest-tundra and partly in the subzone of south tundra is, in practice, quite possible. To form productive seed-bearing plants of local grass species it is absolutely necessary to continue such investigations.

Some approaches to biological recultivation in northern conditions are being developed along the Charyaga-Vozey-Usa-Ukhta pipeline and on gold prospecting sites in the Kozhim River basin. Agrotechnical measures applied on seed-producing plots have ben developed: hydro-planting along pipelines has been introduced and experimentally, standards and time-limits have been developed for seeding, the composition of grass-mixtures, fertilizer introduction, including new organic-mineral (COM-fertilizers) in the form of hydrolytic lignin, SKOP substances made from forest-paper industry wastes and bacterial preparations. There has been some experimental work conducted on the problem of phyto-reclamation of lands polluted by oil.

Biological recultivation is also aimed at the monitoring of natural vegetative succession, the development of methods for the application of agrotechnical products, together with the enhancement of characteristics in vegetation and substrates in preparation for the following stages (reclamation).

In connection with the estimation of the stability of various zonal types of BGC (Biogeographic Communities), values of established economic (technogenic) loadings (ecological examination), BGC of natural zonal systems (ecological monitoring) appear to be rather promising.

POPLAR TYPES RECOMMENDED FOR TESTING IN THE NORTHERN REGIONS OF FOREST ZONE

V.I. Bakulin
Central Siberian Botanic Garden, Siberian Division of the Russian Academy of Sciences, Novosibirsk

Representatives of Poplar (*Populus L.*) are widely used for green-belts, forest economy and different types of protective plantings because of their rapid growth, decorative properties, high resistance to air pollution and easy vegetative propagation. Recently poplar varieties have been used for recultivation of disturbed landscapes.

Poplar varieties grow successfully in moderate climate. The possibility of their growth in the North is complicated by the low frost-resistance of many kinds, sorts and forms of poplar. Only a few varieties of poplar are good for cultivation and recultivation. Taking into consideration the long-term experience of introduction and selection of poplar in Siberia (Bakulin, 1966,1986,1990), it is possible to recommend the following kinds and hybrid forms for testing in the northern regions of the forest zone: *P. suaveolens Fosch.* - is popular in Eastern Siberia from the Baykal region to the Chukcha Peninsula. Along the river valleys it goes up to the forest and tundra border. It possesses an exclusively high frost-resistance and "winter-resistance" and can stand temperatures to about -64°C. It is polymorphic, that is why it is used in Yakutsk and Magadan and other cities for cityscapes and greenbelts. It is grown mostly in the area of its natural range, but can be found in the collections of Botanic Gardens in Siberia. Poplar can be easily reproduced by grafting with a 90% assurance of success.

P. nigra L. - black Poplar. This Poplar type covers large areas but, Siberian types are of greatest interest for introduction to the northern regions. It is a frost-resistant perennial, in the river valleys where it can stand protracted floods. Black poplar is usually reproduced by sowing seed as it is difficult to reproduce by grafting.

P. balsamifera L. - northern American type. In Russia it is cultivated almost everywhere and in Siberia is widely used in greenbelts and protective afforestation. It grows quite rapidly and is rather frost-resistant and also resists fumes. Successful reproduction can be achieved by grafting.

P. newesis Bogd. - Neva Poplar of Bogdanov's selection. This tree was produced in 1934 from the crossing of Canadian Poplar with *P. balsamifera L.* In Novosibirsk it is

characterized by high frost resistance and rapid growth. This type turned out to be resistant in Arkhangelsk also.

From the hybrid forms of Siberian selection, hybrids No. 25 and No. 40, produced in 1971 (Bakulin, 1980) by crossing Moscow and Altay Poplars, can be recommended for testing in the northern regions of the forest zone. These hybrids grow rapidly (annual net growth is about 1.5 m). They can be reproduced easily by grafting and in the climate conditions of Novosibirsk do not freeze even during severe winters.

It is necessary to note that the reproduction success of highly productive poplar trees depends not only on the variety of types and forms, but also on the correct choice of the types of land areas where they will grow as well as on the wise use of the necessary agrotechnical methods.

PECULIARITIES OF THE GROWTH OF CROPS ON SOILS WITH OIL-WASTE POLLUTION IN CONNECTION WITH THE PROBLEM OF LAND RECULTIVATION

A. Baranov, V. Evdokimov and Ch. Kolesnikov
Research-Industrial Complex "Belogorka", Russian Academy of Sciences, St. Petersburg

In Russia the land area removed from agricultural use as a result of the extraction of oil, is about $1x10^6$ ha. Active surface elements (ASE) found in oil waste tailings play an important role in environmental pollution. ASEs are widely used in drilling of oil wells; in revealing of productive strata; for the increasing of the output of the producing oil wells; in the process of preparation (purification) of oil and industrial sewage waters. ASEs accumulate in the surroundings as a result of a technological waste processes, and produce significant impacts that influence the development of soil organisms and plants.

It is significant that the processes of natural self-purification and restoration of oil-polluted soils take place extremely slowly - at least, decades. In connection with this, the goal of recultivation is the creation of the necessary favorable conditions on such lands for the regular growth of higher plants and both wild and cultivated crops. However, it is also necessary to take into consideration the fact that some molecular components of oil and waters accompanying it in the process of extraction, actively influence the growth of the higher plants and soil microorganisms; therefore it is important to study the effect of the concentration of oil-waste pollutants on the growth of seeds and different kinds of plants.

In experiments the seeds of *Triticum aestivum*, *Hordeum*, *Avena rape* (winter, spring), *Raphanus sativus* and *Amaranthus* were used. The plants were grown in pots containing 5 kg of dry soil, into the upper layer (0 to 10 cm) of which doses of oil-waste waters were introduced. The seeds were germinated using the rolling method on water and oil-waste solutions with and without the presence of oil.

The seeds of *Avena*, *Triticum aestivatum* and spring rape grew in the solution of oil-waste waters, as well as, in the control using water alone. The presence of oil in the oil-waste solution caused a complete cessation of wheat growth, only a few seeds germinated, but produced no shoots. Seeds of *Avena* produced both roots and shoots, but the growth of the coleoptile and the first leaf was depressed. There was no depression in the growth of rape.

In the experiments with doses of oil-waste introduced into the soil, high concentrations caused a reduction of growth, especially in the initial stages. Plants of *Hordeum*, *winter rape* and *Ratanus sativus* with doses of 2 and 10 liters show the effect of stimulation, but those exposed to doses of 50 showed a depression of growth. The leaf size of *Hordeum* treated with the stimulating doses was 20 to 25% greater than in the control version and leaf size with 50l oil-waste were reduced 20 to 25%.

All of the oil-waste doses tested, negatively influenced the growth of winter rape plants during the first two weeks, but at the age of a month only the highest dose (50) caused a suppression of growth. Doses of 2l and 10l increased plant biomass by 30 to 100%, and leaf area by 250%.

For the crops tested the graded doses of oil-waste waters provides only a rough approximation, i.e. showing only the dose causing growth stimulation for the certain age of plants, and the dose at which growth suppression begins.

THE USE OF INTRODUCED VEGETATION SPECIES OF SOUTHERN ORIGIN FOR SLOPE STABILIZATION OF GROUND ENGINEERING CONSTRUCTION IN THE LOWER COURSE OF THE OB RIVER

A. Yu. Belyaev and I.I. Shilova
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Yekaterinburg

In the regions of intensive development in the lower course of the Ob River construction activities involving large-scale excavations take place. In the course of excavations, the slopes of highways, construction and industrial sites, dams and other surface engineering projects are covered by local soil materials consisting of alluvial-lake sands (mainly fine sands) and silty loams. Such covering, especially on slopes, is subject to intensive water erosion and solifluction. Due to the size of these constructions the exposed slope area created is large. That is why their immediate stabilization is of great ecological and economic importance. The considerable variety of microclimatic conditions on slopes with different steepness and aspect permit the successful use of different plant species for slope sodding. It is very difficult and sometimes almost impossible to obtain seeds of needed cultures (species) in the necessary quantity for the northern regions of our country. That is why it is important to know what other plant species might be substituted.

Our experiments have shown, that in the climatic conditions of the lower Ob River region it its possible to use some species of cereals and leguminous fodder plants to stabilize warm (south-facing) slopes. There plants grow mainly in the forest-steppe and steppe zones where the seed production is high. Under conditions of Nyagan-town (Tyumen region) we tested Italian rye grass (a quickly growing annual plant) and sweet clover (the mixture of white and yellow, two-year plants). The experiment was started in 1988 on steep (40 to 50°) and high (5 to 6 m) slopes of concrete highways. The slopes were composed of local soil materials containing insignificant quantities of available nitrogen, phosphorus and potassium. The seeding was done by hand in the beginning of July directly on mineral substratum, by means of forming narrow terraces at 40 to 50 cm intervals and simultaneously introducing mineral fertilizers. The main good qualities of the above species became evident as the experiment progressed: rapid development of a plant, short life cycle, high germinating capacity (98 to 99%) and germinating energy (90 to 92%) of seeds and reproduction by self-seeding.

The very fast development of Italian rye grass prevented wash-outs on the slopes, the mass ripening of seeds at the end of summer gave the appearance, the next year, of a thick self-sown crop, normally developed after additional introduction of fertilizers. Sweet clover seeded as scarified seeds, at the end of vegetal period formed a thick grass stand. Long main roots (up to 30 to 40 cm) and 1 to 2 prolonged shoots on each plant were formed. During the winter period considerable thinning of the sweet clover field took place, but well-developed roots of dead plants firmly retained the ground on the slopes. Plants grown in the spring through summer period reached a height of 100 to 150 cm, produced an abundance of flowers and fruit, and formed viable seeds. In the third year very thick self-sown crops of both sweet clover species (200 to 400 plants per m^2) appeared and developed normally without fertilizers.

For more reliable highway slope fixation, cuttings of rapidly growing species and willow hybrids were recommended and presented for our experiments by V.I. Shaburov. They were planted together with grass seeding. The rooting was practically 100%. During the next year, on average, up to 70% of living plants remained, having annual shoot growth of 80 to 100 (up to 180) cm.

HYBRID WILLOWS AS PROSPECTIVE RECULTIVANTS FOR THE DISTURBED NORTHERN LANDS

I.V. Belayeva, V.I. Shaburov and A.P. Dyachenko
Institute of Forest, Ural Division, Russian Academy of Sciences, Yekaterinburg

Active technologic exploitation of the northern regions is accompanied by an intensive burden on nature. As a result of these activities we observe the formation of large regions on which the vegetation is either damaged or totally destroyed. Because of the low rate of natural restoration of northern phytocenosis, rapid and effective methods for the restoration of the vegetation covering on the disturbed lands are in great demand. One of the most

successful vegetation restorative works employ varieties of *Salix lanata*. This plant possesses a high ecological plasticity, intensive growth and can be reproduced by both vegetative and sexual means. This permits the willows to occupy different technogenic substraits (Shilova, Shaburov, 1978; Kulagin, 1982,1990).

Among the wild types of willows the most likely recultivants are: *Salix triandra L., S. viminalis L., S.dasycla-des Wimm., S.caprea L., S.cinerea L., S.myssinifolia salis b., S.phylicifolia L., S.resmarinifolia L.* Some hybrid willows demonstrate good qualities as potential recultivants. Thus, for example, in our investigation on the technogenic sands of Perm (Belyaeva, 1987) the hybrid willows *Salix triandra* and *S.lanata* have shown good adaptation to the conditions of growth and their very high compatibility, compared to the local types of plants. The potential of hybrids as the plants acceptable for recultivation was proved in experimental plantings on the technogenic sands of the Nyangansk hydroelectric station. Here hybrid willows *S.schwerinii* x *S.dasyclados*, *S.schwerinii* x (*S.schwerinii* + *S.udensis*), *S. pentandra* x *S.fragilis*, *S.triandra* x *S.dasyclados* have shown an even better adaptation of shoots and a higher growth rate than pure types.

In connection with the above willows produced by hybridization are of more practical value. A collection of these plants (about 60 hybrids) is being cultivated in the Botanic Garden of the Ural Division of the Russian Academy of Sciences. The hybrids, represented in the collection, possess a wide variety of biological specialization that can be used for recultivation of different types of technogenic landscapes.

RECULTIVATION OF DISTURBED LANDS ON THE ROUTE OF BAR (BAIKAL-AMUR RAILWAY)

O.P. Bobrinev and M.A. Grin
Institute of Natural Resources, Siberian Division, Russian Academy of Sciences, Chita

As a result of the construction of the Baikal-Amur Railway along the Chita portion of the right-of-way, more than 1500 ha of quarries were excavated . For the most part, they are located in close proximity to the railroad right-of-way which reduces the surface protection offered by the forests and contributes to the destruction of the inter-relationships is the natural environment. The presence of such large areas of damaged lands negatively affects the state of the permafrost (warming it and/or increasing the depths of the active layer), and allows for erosion by both wind and water, generally degrading the ecology.

At the same time, questions regarding the natural and planned reforestation of the disturbed forest lands in the areas in question have been only briefly addressed, and the on-going efforts towards recultivation do not satisfy the current demands for reforestation.

A research effort into these conditions was directed towards a reduction in the cost of the technology for reforestation and the development of grassy vegetation on the disturbed lands

by using the very forces of nature itself. In that connection, we examined both the disturbed lands along the BAR right-of-way as well as similar sites formed as result of construction of other projects, as much as 20 years ago.

Analysis of the restoration of the vegetative cover at the quarries excavated some 15 to 20 years ago, and comparison of these results with the propagation of plant growth at similar sites, developed during the construction of the railway, enabled us to observe and to validate a series of methods, governing the recultivation for a given region.

The quarries situated along the BAR right-of-way (in the Chita region) were classified according to size (small - up to 5 ha, medium - 5 to 10 ha, and large - more than 10 ha) and according to the mechanical composition of the soil material (sandy, gravely, rocky). The quarries were further classified into groups according to the method of reforestation: those remaining with natural growth; those requiring measures which can be accomplished through natural regeneration; and those where trees must be planted. All the sandy and gravely excavations with widths up to 300 to 400 m were such that reforestation could be left to natural regeneration. In excavations greater than 400 m, it becomes necessary to plan for the planting of trees in the central portions. Adjacent to the existing forest, a bordering area 150 m in width is left to natural regeneration.

In rocky excavations 300 to 400 m in width located within the forest block, it is necessary to lay down a porous, fertile layer of soil to a depth of 10 to 15 cm, and to leave it for the natural regeneration of the trees and bushes. The soil layer can be placed in strips 1.5 to 2.0 m in width, spaced 2 to 3 m apart. Rocky excavations wider than 400 m require planned reforestation. In such locations it is necessary to treat the surface and to place 20 to 25 cm. of fertile soil in strips 2 to 3 m wide. Such a procedure should be done in the central portions of the excavations, leaving the outer 180 m free to support natural regeneration from the forest walls. In all the excavations situated far from sources of natural seeding, planned reforestation must be performed.

RECULTIVATION OF THE VEGETATION OF BOGS

M.S. Boch
Komarov Botanic Institute, Russian Academy of Sciences, St. Petersburg

During the last decades the anthropogenic impact on bogs has increased significantly. The major factors disturbing the bogs are peat extraction, forest and agricultural development and construction on the peat grounds. Bogs are the most sensitive ecosystems and can be destroyed totally even by small impacts. Mossy and grassy associations are the least resistant and dry mossy and wood-mossy associations are most resistant. During the peat extraction process and agricultural improvement the bogs can be destroyed totally, and only peat deposits in the form of smooth fields and peat quarries remain. Their vegetation is replaced by the agricultural crops (on the fields), weeds (on the exploited peat bodies) or water and

shallow-water plants (in the quarries). During forest development some boggy plants remain although the major part of them often dies, including the sphagno-mosses. At construction sites the native vegetation is replaced by ruderal vegetation. Many bogs are being affected by contamination caused by the oil and gas industry spreading of oil and gasoline materials industrial dumping, as well as by drainage, e.g., from various agricultural and industrial enterprises.

As a result of development of bogs the productivity of the lower levels of vegetation decreases to near zero, variety decreases significantly and the boggy flora disappears almost totally. When the bogs are polluted, productivity can increase 2 to 3 times, but ruderal types of vegetation (*Tussilago, Urtica, Chamerion*) alien to the bogs appear and the variability of boggy flora decreases sharply. Sometimes on the raised bogs alien species from the lower bogs invade, i.e., *Alnus glutinosa*, mosses, and *Carex*.

The appearance of the disturbed bogs is hardly attractive and gives little any hope for their restoration. However, long-term investigations by the author give some grounds for optimism. It turns out that bogs appear to be one of the most easily and quickly regenerated ecosystems, due to the peculiarities of plant structural forms and deposits of genetic material contained in the peat, i.e., seeds and spores. After the impact that destroyed the bog is removed its regrowth begins with boggy species of ruderal vegetation. On the raised bogs the first to appear are Eriophorum spp. and sphagno-mosses, on the lower bogs - *Carex spp.* and different boggy grasses. According to the author's observations the tracks produced in the bog by mechanical damage regrew in 1 to 2 years, traces of pollution are gone in 5 to 7 years (depending on the degree of pollution).

Taking into consideration the properties of boggy vegetation, biological recultivation, i.e., reseeding is not recommended for bog restoration. The alien plants will not grow on the bog and boggy plants will take their place without recultivation. It is recommended that further disturbance stop, and that groundwater levels be kept high to encourage natural restoration.

ANTHROPOGENIC ALTERNATION OF VEGETATION ON OIL POLLUTED TERRITORIES

L.V. Chalysheva and V.P. Gladkov
Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

The problem of reconstruction of the vegetative cover on the territories polluted by oil has become rather acute. Severe climatic conditions of the Far North restrict the processes of natural microbiological destruction of oil found in the soil. As a result it is impossible to use rather large areas, and they appear as "technogenic badlands".

We made an attempt to study the recovery potential of northern vegetation communities on the lands of one of the oil industrial ventures situated in the subzone of the far northern taiga north-east of the European part of Russia. Natural regrowth was studied on 2 x 2 m. experimental plots in a 5-fold repetition in different parts of the oil polluted lands. The studies included estimation of area covered by grass stands and the species composition and morphometric characteristics of the plants.

In the formation of secondary anthropogenic alternations of vegetation on technogenic landscapes we distinguish 3 stages characterized by particular vegetation composition that are related to the presence of great quantities of hydrocarbons in the soil and on its surface. The first stage can be estimated as a nidus or a beginning. It is common to all types of areas and at any level of pollution and includes Marsh horsetail (*Equisetum palustre*), cotton grass (*Eriophorum*), buckbean (*Menyanthes sp.*) as pioneer species. The cover is up to 5%. The second stage is one of pioneering species and is characterized by the formation of monospecific vegetation groups. Standing cover reaches 50%. Under conditions of moderate wetness of the mineral soil communities of marsh horsetail predominate. Buckbean overgrows the greater part of bogged-up areas. The third stage of re-vegetation is characterized by a grass-stand structure and the introduction of new species into the newly forming communities. The surface cover is up to 80%.

As a result of anthropogenic alternation of vegetation on technogenic lands, the forest vegetation type is changed by a diversity of bush-grass; the process is one of mesophytes being replaced by local communities of gigrophyts.

ON THE ROLE OF RODENTS UNDER THE CONDITIONS OF ANTHROPOGENICALLY DISTURBED TUNDRA BIOCENOSES

A.N. Danilov
Ural Division, Russian Academy of Sciences, Yekaterinburg

Disturbances in the continuum of tundra vegetation and soil greatly affect animals, especially rodents. Disturbances resuling from heavy caterpillar vehicles may lead to artificially created retreats for smaller mammals. Insignificant disturbances of vegetation produce little dislocation of animals. However, in the places where disturbances are great and occupy large areas small animal populations are greatly reduced.

A 3 to 5 times increase of animals in anthropogenic conditions results in an increase in herbivory on the vegetation of disturbed tundra biocenoses; in addition, intensive digging activity of animals greatly affect the processes of soil formation. The effect of rodents, even on undisturbed vegetation communities is rather great and the increase of herbivory under the conditions of anthropogenic disturbance of the soil surface may lead to the loss of great quantities of phytomass. According to our observations such a situation can also be seen

under conditions of unsatisfactory recultivation of disturbed tundra biotops. Because of the influence of herbivore the effectiveness of recultivation measures is reduced.

Changes in the spatial distribution of rodents under anthropogenic conditions, from our point of view, result in a reduction in the process of vegetation reconstruction on moderately disturbed tundra areas. However, the life activity of animals promotes an increase in the rate of the surface phytomass transformation into the litter. The consequent enrichment of the soil with biologically important, and easily assimilatable elements affects the rate of the transformation of matter to energy in tundra biome productivity. This process promotes an instability of tundra biocenoses to anthropogenic impact. To conclude, in the process of tundra development it is necessary to take into consideration changes in tundra animal populations.

DEVELOPMENT OF OPTIMAL METHODS OF BIOLOGICAL RECULTIVATION OF WORKED-OUT AREAS IN THE KOZHIM DEPOSIT

S.V. Degteva and E.I. Shteiner
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

The areas of technogenic landscapes continue to grow due to the increase in the industrial production. The territories disturbed by these processes very often are turned into industrial deserts that negatively affect adjacent ecosystems. That is why there is an unquestioned necessity for recultivation of disturbed areas. The process of reconstruction of biogenocenoses in the North presents special problems, because they are extremely sensitive and for a long time the problems of biorecultivation in northern regions of the country was ignored since they were not considered to be profitable for agriculture.

The scientists of the Institute of Biology, Komi Science Centre, have been carrying out investigations connected with the choice of different techniques of plant recultivation of worked-out areas in the Kozhim deposit. The study of succession in the natural recovery of vegetation together with experiments conducted over a 5 year period lead to the conclusion, that the optimal choice for biorecultivation is crop cultivated using local species of perennial grasses.

In 1990 a series of new experiments was started. The aim of which was to develop new agricultural methods: estimation of optimal seeding rates and doses of fertilizers and testing of organic-mineral fertilizers (COM), composed of hydrolithic lignin and microbiological preparations. To increase the assortment of species, suitable for biological recultivation of disturbed areas, test plots for 13 species of perennial grasses were set up.

During the first year of observations a positive response was seen after the application of COM fertilizers and microbiological preparations (mizarin, fluvobacterin). It should be

noted that the effectiveness in this case was greater than after mineral fertilizer application. In most cases, in the series of experimental plots, seed germination was higher than in control tests and the plants showed better development. Application of fertilizers in the first year of seeding resulted in better growth and development of the plant; notwithstanding the dose of a fertilizer both control and experimental plots showed great variability. The effect of fertilizers on the amount of brairds is shown only on the plots with unsatisfactory substrait properties.

The data obtained from the test plots and the results of natural recolonization studies lead to some preliminary conclusions: in the process of recultivation of worked-out areas of the Kozhim deposit such plants as meadow grass (*Poa pratensis*), Hungarian Brome grass (*Bromus inermis*), reed canary grass, red fescue grass (*Festuca rubra*), sheep's fescue grass (*Festuca ovina*) are quite suitable. The experimental work is continuing.

RENATURALIZATION OF PLANTS ON DUMPS OF EXHAUSTED MINERAL FIELDS OF THE POLAR URALS AND AN ESTIMATION OF POSSIBLE METHODS FOR PLANT PHYTORECULTIVATION

S.V. Degteva and G.A. Simonov
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

Through the period 1986-1990 studies were conducted to define conditions and choose the optimal ways for biological recultivation of dumps on the Kozhim deposit (the western macro-slope of the Polar Urals). The region under study is in the Ural-West Siberian province of the Euro-Asian taiga. It is situated in the upper part of the mountain-forest belt at an elevation of 450 to 600 m above sea level. The vegetation cover consists of shrubby-green mosses, coniferous woods, deciduous forest and shrubby tundra plants.

The study of natural reestablishment of plants proceeded recommendations on biological recultivation of the dumps. In total, in the technogenic ecotopes, 80 descriptions of portions of the plant cover were completed. The period of time since the end of mining ranged from 1 to 7 years. On the disturbed areas 177 species of vascular plants and 6 species of mosses were identified, natural flora loss is about 55%.

In the process of technological development of industrial sites, soils and plants were completely destroyed and specific elements of technogenic relief were formed. The main limiting factor in natural revegetation of the dumps is the composition and properties of substrate. As the content of fine grained soil increased so did the total standing plant cover as well as the species diversity in the areas of plant cover. On the whole the rate of plant restoration is very low. On the technogenic sites there were areas with standing plant cover of between 5 and 20%. In ecotopes where the subsoil was subjected to less intensive disturbance and contains a comparatively high quantity of fine grained materials there are

open phytocenoses in which the total standing plant cover rarely exceeds 40 to 50%: such areas are spatially small. During 5 years the index of total standing cover increased only 4 to 15%.

The areas of secondary plants usually have 1 or 2 dominants, which during the period of observation did not change. The same few species of herbaceous plants take the lead in overgrowing on all elements of technogenic relief: *Poa pratensis, P.alpina, Festuca ovina, Chamerion angustifolium, Equisetum arvense*. Of mosses there is an abundance of *Funaria hygrometrica*. Tree species have only weakly regenerated; out of the shrubs, willow is found most often. All of the dominants are apophytes which in technogenic habitats have an advantage over other species due to their wide ecological amplitude and their ability to form a sufficient number of seeds and spores even in the severe climatic conditions of the Polar Urals. On the whole, the species composition of areas where plants are recovering is in many cases without design and most of the species are rare and few in number. The formation of communities of weedy-ruderal plants has not been determined.

In spite of the fact that the fragments of plant cover consist of species of apophytes, the recovery of plants is proceeding toward the zonal type. In comparison with native communities, secondary groups are characterized by a simplified structure, monodynamics and the presence of clearly expressed co-dominates. Secondary plants are less diverse and to a lesser degree reflect the specificity of ecotopic conditions. The greatest cenotic role, in the first stage of the process of revegetation, is played by species which are not in abundance in the primary communities. In the hierarchy of technogenic habitats the change in the mutual relations among life forms, botanical, cenotic and geographical groups of species is marked. Zonal peculiarities will evidently start to reveal themselves at the later stages of plant syngenesis.

It is advantageous to sow perennial herbs, from local populations to promote natural recovery of plant cover on planned dumps. In monocultures of meadow grass and red fescue sown at 25 and 15 kg per ha. accompanied by small doses of mineral fertilizers the formation of agro-cenoses takes place in the 4th year, with a total standing cover of 55 to 65%. The plants are well developed, brushy and most of them have numerous (15 to 100) generative shoots with a height of 20 to 65 (100) cm, and produce seeds. Meadow grass and red fescue dominate in sowing. Roots of apophyte-species are also noted. Among them *Festuca ovina* and *Chamerion angustifolium* occupy a dominante place, while *Poa alpina* and *Carex brunnescens* are more rare. The above mentioned species determine the composition of plant groups that form during re-naturalization of plants. The number of weeds is low.

MECHANISMS OF ADAPTATION OF ALOPECURUS ARUNDINACEUS DURING ANTHROPOGENIC TRANSFORMATION OF BOGGY LANDS

T.A. Elizarova
Institute of Agriculture, Tyumen

One of the factors preventing the expansion of agricultural fields in the Tyumen region is the abundance of moisture in the soil of the flooded and boggy meadows. Such lands could be successfully transformed into highly productive hay-fields by deep or shallow drainage and overseeding with some valuable types of grasses.

Traditional types of grasses used for creation of non-native or the improvement of natural hay fields can not tolerate the spring floods. Natural populations of wild flora serve as a source of evolutionary-adapted material for selection of highly productive and resistant types of grasses.

The adaptive potential of *Alopecurus arundinaceus* is being investigated. The plant is one of the most suitable types for the Tyumen region. It has the property of rapid physiological maturity which is of special important once in the process of development of meadows in the North of Tyumen region where the vegetative period is short.

While studying the vegetative reproduction of *Alopecurus* it was found that the spring flood stimulates bushing. Under conditions of a high moisture supply, in the second year of growth, the increase of the number of shoots was between 20 and 35%, compared to plants growing in mesic condition. The growth of *Alopecurus* also changes, with an abundance of moisture it forms a continuous herb-wall, because the closely spaced plants mutually penetrate each other as they form long roots - up to 10 to 15 cm - with an even placement of renewing buds. During the melioration of bogs it is necessary to take into consideration, especially during the first years,the spring moisture conditions on the already established *Alopecurus* association.

Alopecurus arundinaceus competes successfully on meadows used for hay harvesting because some part of the population have ripe seeds before the first harvesting. This is so because of the period of flowering and ripening of some individuals is extended from 5 to 7 to 9 to 15 days. This makes harvesting of seeds a little difficult, decreasing the yield 20 to 30 percent. The longevity of *Alopecurus* is up to 10 to 15 years.

LONG-TERM NATURAL RECOVERY OF DEVELOPMENT RELATED DISTURBANCES IN NORTHERN ALASKA

K.R. Everett[1], D.A. Walker[2], and P.J. Webber[3]
[1]Byrd Polar Research Center and Department of Agronomy, The Ohio State University, Columbus, Ohio 43210, USA
[2]Joint Facility for Regional Ecosystem Analysis, Institute of Arctic and Alpine Research, University, University of Colorado, Boulder, CO 80309, USA;
[3]W.K. Kellogg Biological Station, Michigan State University, Hickory Corners, MI 49060, USA

Limited exploration for hydrocarbons in the tundra of Alaska north of 60°N began in 1944 and has continued sporadically since. Both exploration and development in the north accelerated rapidly after the discovery of major oil deposits at Prudhoe Bay in 1968. With this development have come requirements for reclamation and/or restoration of tundra disturbed as a result of off-road vehicle movement, borrow pits, drill and storage pads, and roads and airfields. Since the mid-1979's considerable attention has been given to the implementation of land use plans employing Geographical Information Systems (GIS) and landscape rehabilitation techniques.

Attempts at reclamation and restoration of disturbed tundra commonly have proven costly to initiate and to maintain and often involve the use of exotic (extra-regional) vegetation. In many cases these attempts have been quite unnecessary. had scientists and engineers understood the rates and courses of natural adjustments in thermally and/or mechanically disturbed tundra environmentally sound and cost effective decisions to let nature take its course might have been made. To achieve this understanding requires a careful appraisal of existing old (20 to 50 years) disturbances.

Study of old disturbances in northern Alaska has shown that wet sites with low species diversity show the greatest recovery potential for vascular plants and some sites appear nearly fully recovered after 20 years. However, the recovery of the less obvious cryptogam component appears to take much longer. There is an indication that recovery in wet sites that underwent thermally-induced subsidence can regain their original surface topography as a result of subsurface ice build-up.

Recovery potential for mesic sites with ice-poor mineral substrate is great if the organic surface materials were not removed, but incorporated with the substrate. Mesic tundra with large volumes of wedge ice undergo progressive topographic and biological change over a period of 30 or more years and may not reach equilibrium for a century or more. Fell-fields commonly show relatively little recovery from vehicle disturbance especially if shallow blading has been done. Significant re-establishment of cryptogams, *Dryas* sp. and other mat formers has not taken place in 20 years. Excavations involving bedrock removal remain essentially unchanged over a 30 year period and will probably require centuries to millennia to reach a configuration suitable for natural revegetation.

Dry bladed surfaces such as runways develop a windblown surface and may support a diverse assemblage of mesic and xerophytic species (10-25% cover) in 20 years, especially if adjacent seed sources are left intact. Constructed surfaces such as drill pads and access roads show only small natural recovery since they are removed by elevation from adjacent oftentimes wet tundra and are highly compacted. Such surfaces will take several centuries at the natural rate of $0.05\% \cdot yr^{-1}$.

Studies of natural reclamation of disturbed tundra thus permit a cost-effective program of reclamation focused on sites with unacceptably long periods (>100 years) in which to achieve stability or disturbances such as drainage impoundments and dust shadows that propagate rapidly and affect large areas. This knowledge, coupled with the application of GIS and Geobotanical mapping in the planning stages of future development will minimize landscape disturbances that require costly mitigation.

ANNUAL FODDER CROPS ON BOG SOILS OF THE POLAR REGIONS IN TYUMEN PROVINCE

R.N. Fattakhov
Institute of Agriculture, Tyumen

Investigations were carried out in the neighborhood of Nadym on the effectiveness of annual fodder crop cultivation on peat soils without irrigation. The thickness of a peat layer on the experimental plot is between 15 and 58 cm. Beneath the peat are fine to medium grained quartz sands. The value of pH_{KCL} of the virgin peat-bog is about 3.0. Dolomite flour was used to neutralize soil acidity at the rate of 8.0 tons/ha. Mineral fertilizers were added in the amount of $N_{120}P_{120}K_{120}$ kg ha^{-1}.

The results of the tests showed that under conditions of natural moistening and warming of the peat-bog produced an economically valuable green fodder crop. In the cultivation of annual grasses with preliminary removal of the moss-shrub root mat and further soil additions of Dolomite flour the following cultures produced the largest yields: oats (*Taezhnik*) - 200 to 366 centners per ha, spring rape (*Salut*) - 134 to 307 centners per ha, radish (*Tambovchanka*) - 190 to 390 centners per ha of green material.

The greatest quantity of green material production using a technology of peat-bog cultivation without removal of moss-shrub root mat (with mechanical treatment) gave such cultures as: oats 186 to 285 centners per ha, radish (*Tambovchanka*) - 184 centners per ha, spring colza (*Sibiryachka*) - 140 to 274 centners per has, white mustard (*VNIIMK*-162) - 140 to 200 centners per ha. The green fodder crop on a control plot from which the root mat was removed was higher than that on the treatment plot.

Studies conducted in 1989 of the temperature regime of the soils on virgin and cultivated plots showed that the soil temperature on a cultivated plot was, 1.4 to 6.8°C higher than

that on the virgin land. On the virgin plot the frozen ground was recorded at a depth of 40 cm until July 9 (T: - 0.1°C).

DYNAMICS OF THE GROWTH AND PRODUCTIVITY OF THE SOWN GRASSES (ACCORDING TO OBSERVATIONS IN THE POLAR ZONE OF YAKUTIA)

M.K. Gavrilova
Institute of Frozen Soils, Yakutsk

The Polar Zone of Yakutia constitutes a large reserve for the development of animal husbandry in the Yakut-Saha , which comprises nearly 40% of the territory of the Republic. The average harvest from the meadows in the southern half of this region is 1500-2000 kg/ha which can be used for large scale cattle breeding, and on the reclaimed (dry) land, in the most favorable years, up to 5000 kg/ha. In the permafrost areas a rapid degradation of the meadows takes place, which requires their improvement, particularly, in the form of seeding grasses. In the years from 1983 to 1986 our Institute conducted experiments on the meadow range in the locale of Syaganny. On 14 sites with, *Avena-pisum* mixture, *Agropyron* and *Leymus*, thermal and soil moisture observations were made during 3 summer seasons.

In the first year of growth the height of the seeding grasses reached 30 to 40 cm for the *Avena pisum* mixture (annual grasses) and in some places 50 to 60 cm; the remaining seeding (perennial) reached 10 to 15 cm; the harvest of *Avena pisum* mixture was nearly 1150 to 5000 kg/ha. of moist grasses an 1200 to 2400 kg/ha. of hay. The highest productivity was on the irrigated site, followed by the relatively dry site. The harvest of *Agropyron, Leymus* and their mixture was 2000 to 2600 kg/ha. of wet grasses and nearly 500 to 600 kg/ha. of hay and perennial grasses. The perennial grasses looked better on the dry sites. The irrigated and flooded sites, subjected to these seeding, were actually half barren.

The second season of growth gave different quantitative data. The greatest growth was on the dry sites and in the middle part of the irrigated zone. But the herbage that summer was 3 times higher than in the first year. The tallest grass was 60 to 70 cm (*Agropyron* grass mixture) with some grasses reaching 85 to 90 cm. The greatest harvest (3000 to 3500 kg/ha. of hay) was from the dry sites; on the irrigated sites it was 1000 to 1500 kg/ha. The least harvest (400 kg/ha.) was from the flooded, neglected sites with the *Avena pisum* mixture. On the whole, the grass harvest of the 2nd year was 5 times higher than in the 1st. In the 3rd season the perennial grasses reached 80 to 100 cm and higher, that is 1.5 times more than in the 2nd year and 5 times higher than in the 1st. The harvest of these grasses in the 3rd year was 1.5 times greater than in the 2nd, and 6 to 7 times greater than in the 1st.

The research shows that the harvest depends directly on the moisture content of the soils in any one location, although there is some scattering of results. In general, the higher harvest correspond to a lower moisture content (up to 30%). For the seeding grasses the greatest correlation between the harvest an the moisture content shows up, evidently, in the

1st year of growth. In succeeding years, the scattering of results can be greater. For the natural grasses in the area, in each given year, the harvest will be dependent on both the moisture content of the location as well as on the temperatures during the growing season. The observed data can be used in the process of recultivation, and on the disturbed lands of the mine sites located on the forest tundra.

THE NATURAL REGROWTH ON THE DIAMOND MINES OF YAKUTIA

L.D. Gavrilyeva, Z.S.Pavlova and S. Mironova
Department of Environmental Protection, Yakutsk Science Centre, Siberian Division, Russian Academy of Sciences, Yakutsk

The intensive development of the diamond mining industry in western Yakutia has led to the expansion of certain technogenic landscapes over an area greater than 8000 ha. These landscapes are represented by quarries, tailings and drag ranges, located near population centers, and thus are negative environmental impacts.

The climate of the area is distinctly continental with an average July temperature in the city of Mirny of 16.8°C (18.7°C in the city of Yakutsk) and a January average temperature of -32.3°C (-43.2°C in Yakutsk) and little precipitation (305 mm a year). These conditions create severe conditions for plant growth.

Geobotanic investigations conducted at the quarries, "Mir", "Udachniy" and "Aikhal", on the complex conditions influencing plant growth and selectivity of the local wild flora in recultivation showed that natural regrowth is moving extremely slowly.

On the basic ecological-floristic classification, using the Broun-Blanquet-method, one class and four basal families of ruderal plants have been delineated on the technogenic landscapes. Those landscapes are distinguished by the chronology of their development and their mineral composition (lime, dolomite, bitum and others). The youngest are characterized by very poor annual and bi-annual types of vegetation.

The middle stage of growth is distinguished by the appearance in the herbage of more stable perennial types of ruderal plants, with an increase in the occurrence of cereal grasses: *Puccinellia hautiana*, *Hordeum jubatum*, and *Agropyron repens*. This stage encompasses 2 basal families and the class *Puccinellio-Hordeetea jubati*. The average projected coverage fluctuates within a range of 20 to 30%, with appearance the of forms of willow and trees and individual types of meadow and forest plants.

Later stages of overgrowth are represented by basal families *Bromopsio pumpillanae-Hordeetum Puccinellio* (*Hordeetea*) and reflect a transition to meadow regeneration of the quarries of the 1950's and 60's.

As a result of this research it is possible to draw several conclusions: 1)the natural regrowth of the quarries is moving slowly and with little effect; we recommend the seeding of types of local flora for recultivation (*Agropyron repens*, *Hordeum jubaticum*, *Poa*, *Alopecurus arundinaceus*) either as direct seedings or transplantation of sod, taken from new quarries, 2) the development of methods for the use of local zeolites in the composition of man-made soils, 3) classification of the technogenic landscapes prior to recultivation.

STABILITY OF VEGETATION IN THE SETTLEMENTS OF YAKUTIA IN RESPONSE TO ANTHROPOGENIC PRESSURE

P.A. Gogoleva and M.M. Cherosov
State University of Yakutsk, Yakutsk

Vegetation of Yakutia settlements consists mainly of ruderal communities. Natural vegetation is preserved on separate plots in parks.

Research has shown that ruderal plants and phytocenoses are good indicators of the degree of disturbance and show the stability of phytocenoses to anthropogenic pressure. Under present conditions when the pressure on vegetation is very strong the appearance of combinations of ruderal species is possible in practically any syntaxon, that is, anthropogenic variations can be found in all associations of the natural vegetation.

Individual ruderal species were defined by Tomskaya, 1981. Initial floristic combinations for ruderal vegetation could possibly be R-species, having strategies which adapted them to live in the conditions of disturbed habitat, appearing on such natural disturbances as eroded slopes, ravins, landslides, and burn areas. Ruderal vegetation undergoes fast evolutionary changes, leading not only to a change of communities but to flora formation.

The following degrees of vegetation stability under anthropogenic pressure is as follows: 1) Unstable (it is inherent in natural types of vegetation either undisturbed or only slightly changed) consisting of the classes *Vaccinio-Piceetea Br.-Bl.*, 1939 em Pass. 1963, *Molinio-Arrhenatheretea* Tx. 1937, *Cleistogenetea squarrosae* Mirk. et al. 1986, etc. Floristic nuclei of the above classes are unstable and disappear quickly from their habitat under anthropogenic pressure. 2) Weak: Natural variations of ruderal vegetation, derivative and basal communities with inclusions of natural species, phytocenoses of the order *Chamerio-Matricarietalia hookerii* ord. nov. prov. and of classes *Bidentetea tripartiti Tx.*, Lohm. et Prag. 1950, *Bolboschoenetea maritimi Vicherek* ex Tx. 1969 ex Tx. et Hulb. 1971. 3) Medium: Communities of classes *Puccinellio-Hordeetea jubati*, Mirk. in Gogl. et al. 1987, *Thero-Salicornietea* Tx. 1954 ap Tx. et Oberd. 1958, *Artemisietea-jacuticae* Gogl. et al. 1987 (separate associations and unions). 4) Strong: Phytocenoses of classes *Caricetea duriusculae* Mirk. in Kashapov et al. 1987, *Plantaginetea majoris* Tx. et Prag. in Tx. 1950, *Artemisietea jacuticae* (separate associations and unions).

At present in settlements of Yakutia strong and very strong communities prevail, which is a natural consequence of irrational use of vegetation. Irregular pasturing of agricultural animals in villages, soil contamination with domestic and industrial wastes in towns and settlements and other reasons result in the poor state of greenery in Yakutia.

PROTEIN POTENTIAL OF LICHEN CENOSES

L.K. Grunina and T.A. Ovsova
Institute of Biology, Komi Science Ural Division, Russian Academy of Sciences, Syktyvkar

Lichens are a significant component in tundra phytocenoses and play an important role in the nitrogen balance of vegetation communities. Some of them, of the genera *Cetraria* and *Cladonia* are the main forage base for reindeer breeding.

Taking into consideration the fact that the protein potential of Lichen Cenoses is not well studied, data is provided here on nitrogen content, protein production and amino acid composition of the dominate lichens in the southern subzone of the Bolshezemelskaya tundra (vicinity of Vorkuta). The nitrogen fixing species included *Peltigera* (Pers.), *Stereocaulon paschale* (L.) *Hoffm.*, *Nephr oma arcticum* (L). *Torss.* and non-nitrogen species such as *Cetraria islandica* (L.) *Ach.*, *C. nivalis* (L.) *Ach.*, and *Cladina rangiferina* (L.) *Harm.* The investigations were carried out on special plots where lichens constituted from 15 to 80% of the total biomass.

Among the lichens studied the nitrogen fixing species accumulated the greatest portion of nitrogen-containing substances (1.3 to 3.8% on a dry weight basis): 60 to 80% of the total nitrogen is biological. The second group of lichens which do not fix nitrogen from the atmosphere, for the most part, have little nitrogen-containing substances (0.6 [avg.] on a dry weight basis).

The conversion of nitrogen to protein at 80% in these lichens amounts to only 4.5 g/m^2. Farther to the north in typical tundras this group of lichens is most abandoned and most important for the economy (reindeer pastures). In spite of the fact that the protein potential of lichens is not high the quality of their protein does not differ from that of other plants in that it contains all proteingenic amino acids including all irreplaceable ones.

As a result of the industrial development of the Far North, and also overgrazing of reindeer pastures, the process of destruction of the lichen cover is widely observed at present. This is followed by the appearance of grasses where the vegetation cover has been disturbed. In the regions under investigation, in river basins, grass-microgroups appear with meadow grass (*Poa pratensis* [L.]) and meadow foxtail (*Alopecurus pratensis* [L.]) both of which are widely used perennials in the formation of artificial meadows in tundra. In comparison with

lichens the protein potential of wild grasses is much higher, 9 to 34 g/m^2. Considering that native grass species form stable microgroups , they can be recommended for use in the reconstruction of disturbed tundra territories.

THE SPECIES OF THE WILLOW FAMILY (SALICICEAE) AS PROSPECTIVE PLANTS FOR FOREST RECULTIVATION IN THE NORTH-EAST OF RUSSIA

A. Yu. Gusachenko and V.A. Nedoluzhko
Botanical Garden, The Far East Division, Russian Academy of Sciences, Vladivostok

The extreme conditions of technologically disturbed landscapes, in combination with sever climatic conditions of the North-East of Russia, make increased demands in the selection of phytomeliorants for forest recultivation. This problem is especially acute when it comes to the development of improved forest cultures for the disturbed territories that are less sensitive to the factors that limit growth. The best prospect in this respect may be representatives of the willow family: *poplar. aspen*, *Chosenia ar.butifolia*, willows (*Salix rorida Laksch.*, *S. udensis Trautv*, *et Mey*, *S. schwerinii E. olf*, *S. hultenii B. Floder*, *S. boganidensis Trautv.*). These species do not have great economic value, but because of their biological peculiarities they are well suited to technogenic substrates poor in nutrients and they are tolerant of air pollution from gases and smoke.

The light weight seeds of willows and *Chosenia* may be spread for large distances and thus populate new and undisturbed territories. In addition such species as *Salix rorida*, *S. udensis*, *S. schwerinii* and others, which because of their ability to form many root shoots, are excellent phytomeliorants for stabilizing technogenically disturbed areas and the prevention of erosion.

The best representatives of the willow family suitable for the following types of forest recultivation are: ameliorative (1); sanitary - hygienic (2); and recreational - greenery plantings (3) (Table 1).

TABLE 1

SPECIES	1	2	3
Salix rorida Laksch.	+	+	+
Salix udensis Trautv. et Mey	+		+
Salix schwerinii E. olf	+	+	+
Salix hultenii B. Floder	+	+	+
Salix boganidensis Trautv.		+	+
Populus davidiana Dode		+	+
Populus suaveolens Fisch.	+	+	+
Chosenia arbutifolia		+	+

Most species of willows are moisture-loving thus, in recultivation it is expedient to use them on the lower slope positions around flooded excavations and in other places with surplus moisture. More drought-resistant species such as *Populus suaveolens Fisch.*, *P. davidiana Dode*, *Salix hultenii B. Floder* may be used for recultivation of slopes and crests of dumps, that is in places with severe moisture limitations. The confirmation of the fitness representatives of the willow family for recultivation is their successful and spontaneous population that appears on dumps, lava and ash fields of volcanos and other categories of disturbed lands in the North-East of Russia.

TRANSFORMATION OF TUNDRA COMMUNITIES UNDER THE INFLUENCE OF TECHNOGENIC AFFECTS

N.I. Igosheva
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Yekaterinburg

In the area of the Yamburg gas field investigations were carried out on the characterization and analysis of the influence of the different components in gas field operation on tundra. The gas field is in the subzone of southern hypo-arctic tundra in the centre of Tazov (Tazovskay) peninsula between the Ob and Tazov (Tazovskay) inlets.

Conditionally, the technologic impacts of the Yamburg deposit may be divided into areal and linear; all complexes of everyday services and industrial construction are erected on a sandy surface. Besides the direct elimination of the soil-plant complex from some areas the operation of the field has an indirect influence on plant cover in the form of sewage waters, organic wastes and changes in the surface water regime. The rate and character of reestablishment of vegetation on sandy excavations and sand-pits depends on their landscape position and the extent of the initial vegetation. On sand-pits in areas of shrub-moss-lichen communities a sedge-cereal-moss community is formed in 5 to 7 years with a total standing cover of up to 50%. Flowering plants (*Arctagrostis latifolia*, *Deschampsia borealis*, *Poa pratensis ssp. alpigena.*, *Carex rariflora*, *Eriophorum scheuchzeri*, *Juncus castaneus*) are spread over the area evenly in the shape of small clumps with a standing cover not exceeding 10%. The greater part of the area is covered by moss areas among which there are species of the initial community (*Polytrichum juniperinum-sp.*, *P. commune*, *P. commune var. diminutun-sol*) as well as weeds characteristic for anthropogenic habitats (*Leptobrium pyroforme*, *Psilopilum laevigatum*, *Pogonatum dentatum-sol.*).

On sandy excavations that are well watered due to restricted drainage, cotton-grass-horsetail-mosses develop open groupings with total standing cover of 60%. The initial vegetation was a tundra-boggy complex. The moss cover is not complete but rather well developed , the erect moss cover accounts for 30 to 40% (*Aulocomnium turgidum*, *A. palustre*, *Polytrichum commune*, *Pochia nutans*, etc.).

On sandy excavations which were previously covered by cotton-grass-sedge-sphagnum bogs and subjected to technical recultivation (the sand was covered by peat and vegetative organs of plants from other habitats), a rich and diverse herbage of cloudberry-cereal-moss groupings forms. *Arctagrostis latifolia*, *Rubus chamaemorus*, *Poa alpigena var. vivipara*, and *Arctofila fulva* prevail. The herbage species composition is diverse: *Polemonium coeruleum*, *Saxifraga cernua*, *Nordosmia frigida*, and *Pedicularis sudetica* et al. A considerable area is taken up by shrubs (*Ledum decumbens*, *Betula nana*, *Salix lanata*) and dwarf shrubs (*Vaccinium vitis-idaea*, *V. uliginosum*, *Andromeda polyfolia*), the moss layer is well developed.

The analysis of vegetation on sand-pits and excavations showed that 5 to 7 years after the anthropogenic influence vegetation groupings form which do not contain even half of the floristic abundance of the initial communities. In addition, the revegetation, as a rule, takes place by adventitious species. In no vegetation communities do lichens occur and these are the main fodder for northern reindeer.

The artificial covering of sandy surfaces with peat introduces seeds and diaspores as well as above plant organs capable of vegetative regeneration and this increases the rate of revegetation. However, complete reestablishment of the initial communities with structure and connections between components characteristic of them, seems impossible.

TYPES OF DISTURBANCES AND SECONDARY RECOVERY SUCCESSIONS IN THE FOREST-TUNDRA (ON THE EXAMPLE OF "MEDVEZHYE" DEPOSIT)

A.P. Ishbirdin[1)] and B.M. Mirkin[2)]
[1)]Botanical Garden, Bashkir Science Centre, Ural Division,
Russian Academy of Sciences;
[2)]Bashkir State University

The growing anthropogenic pressure on ecosystems of the forest-tundra provides the stimulus for study of recultivation technology. The scale of disturbances and the small amount of funds available make it expedient, to make maximal use of the self-restoration potential of ecosystems which is accomplished through secondary succession. The recovery of plants take place with different degrees of intensity and at different orders of succession stages. The time necessary for plant recovery may range from several years (10) to hundreds (300 to 500) of years.

Moisture supply is the main factor determining the rate and direction of recovery successions and consequently the type of recultivation. In conditions of sufficient and surplus moistures, closed, often monospecific communities of Carex and Eriophorum species quickly arise. For disturbed habitats with a moisture shortage grasses participate in initial stages of recovery successions. However, the slow development of cover on bare, well-drained substrata often can not stop the development of erosion processes. Then it is

necessary to supplement the course of natural succession with the aim of accelerating the formation of a sod cover.

The following is a classification of disturbances and the duration of self-restoration processes:

1 - Disturbances with quick self-recovery (up to 10 years):
 a) with single vehicle passage under in conditions of insufficient moisture;
2 - Disturbances with average duration of self-recovery of ecosystems (tens of years):
 a) single vehicle pass under in conditions of surplus moisture,
 b) multiple vehicle passes under conditions of insufficient moisture,
 c) fires;
3 - Disturbances with long-term self-recovery (up to hundreds of years):
 a) multiple vehicle passes under conditions of excess moisture,
 b) removal of the upper horizons of the soil,
 c) heavy pollution by oil-products including anti-erosion oil-based products;
4 - Disturbances after which ecosystems essentially do not recover to the initial state:
 a) flooding (submergence) in the course of linear constructions.

This scheme lists only some of the disturbances which occur in combination with the above factors and their different degrees of intensity.

GEOSYSTEMS OF PIT-DUMP COMPLEXES IN BYELORUSSIA

O.V. Kadatskaya and V.A. Prokopenya
Byelorussian Academy of Sciences, Minsk

As is known, production of useful minerals by open-cut mining results in complete disturbance of initial landscapes including the destruction of soil cover and biota, transformation of relief and a change of the hydrologic regime of the area. The formation of pit-dump complexes can be likened in a number of ways to natural-anthropogenic features, the latter being temporary. In other words production life of such systems is limited by definite time frames and depends on the kind of raw materials, their volume and the production technology. For example, in a region with deposits of construction materials (sand, gravel, clay, chalk, dolomite, rocks, etc) deposits are expended, as a rule in 3-5 to 10-20 years.

After exhaustion of the raw materials the disturbed territories become post-industrial (degraded) geosystems with a considerably changed essential structure. A dynamic and unstable relief prone to erosion is characteristic for them. It is conditioned by factors of both its nature (mode of formation, its geometry and rate of geomorphic development) and technology (processes of raw material production). Soil composition of the disturbed areas differs from the zonal soils by having lower contents of organic substances, biogenic elements and micro-elements and less favorable hydrologic and physical properties. Water

regimes of the geosystems studied are early determined by their orographic, morphometric and lithological peculiarities which in turn determine the potential for infiltration, evaporation and flow of atmospheric moisture.

The transition of the degraded geosystems into an entirely new state is due to reclamation activities, or in the case of no ones intervention, takes place due to processes of self-restoration of soil and vegetation. The choice of directions and methods of recovery of the degraded geosystems depends upon a number of their characteristic. Experience in reclamation indicates the principal characteristics are: character of the technogenic relief, composition and properties of soil mixtures and the hydrogeological and hydrological conditions (amount of surface and subsurface moisture).

Simple technogenic relief together with satisfactory physico-chemical parameters of the disturbed materials and the zonal features of the climate in Byelorussia determines whether recultivation will be directed to forest or to agriculture.

Effective development of the geosystems for forest or agricultural purposes can be based on the first stage of recovery planning, that is, on the initial stage of planning of construction activities. An optimal geomorphological reconstruction of pit and spoil piles is necessary to ensure favorable conditions for the redistribution precipitation as its resources (nutrients) are the major source of nutrition of forest and agricultural plants at the initial stage of regeneration of the soil and vegetation.

During restoration work developing geosystems look like controlled, man made anthropogenic ecosystems in which, depending on the desires and needs of the community, preference can be given to one or another property. Gradually, as the evolution proceeds, area planted to forest pass into the class of ecosystems having both production and preservation functions. The productivity of stable functioning agrosystems, is defined by those who manage them.

AN ESTIMATION OF POLLEN VIABILITY IN GRASSES (BASED ON PHALAROIDES ARUNDINACEA)

N.N. Kruglova
Institute of Biology, Bashkir Science Centre, Ural Division, Russian Academy of Sciences

Phalaroides arundinacea is widely used in biological recultivation of lands along oil-pipelines. However, its extremely low seed crop caused by low real seed productivity and very high fall (lodging) of mature grain prevents its introduction into agriculture. Genetic selection that has worked effectively in the growing of new varieties of Phalaroides that are characterized by higher seed productivity depends greatly on knowledge of the embryology of this plant

and partly on the analysis of pollen viability. Many methods of pollen viability determination were suggested but each one has its defects. The method of mature pollen germination in an artificial nutrient medium in a wet chamber is rather reliable (D.A. Trankovsky). This method should, however, be improved by selecting a nutrient medium optimized for pollen of a specific plant species. In our opinion, in the above case a medium with a composition and concentration of components that provide maximum yield of pollen tubes having the length not shorter than the distance from stigma to seed-bud should be considered. According to our investigations of Phalaroides, such a length is 720± 18 mkm. The optimized nutrient medium for mature pollen germination of this cereal has the following composition: 0.75 g of agar and 30 g of saccharose per 100 ml of prepared solution. Such a medium provides maximum yield of germinated pollen grains, as well as, a maximum yield of pollen tubes with the length not shorter than that stated above.

EXPLOITED RAISED BOGS: CONDITIONS AND PROBLEMS OF RECULTIVATION

T.I. Kukharchik
Institute for Problems of Use of Natural Resources and Ecology, Russian Academy of Sciences, Minsk

The recultivation of the exploited raised bogs is still plagued by a number of insufficiently studied problems. The amount of land which is not used after peat extraction, increases annually. Subject to environmental protection law, the exploited sites should be returned to the land-users in a condition, permitting the use of this land again. However, this requirement, as a rule, is not adhered to. Besides, restoration of the disturbed territories is very often conducted without taking into consideration their individual peculiarities, that influence the effectiveness of the recultivation procedures.

Detailed study of the exploited raised bogs in Byeloruss made it possible to find the significant differences in their condition, caused by both technogenic and natural factors (Kukharchik, 1989, 1990). According to the degree of disturbance of natural properties and functions, inter-component and inter-landscape connection, all the exploited peat bodies were divided into one of two groups: strongly, or very transformed and degraded.

The group of "very transformed" bogs is composed of raised bogs of different types, which have (some) unexploited upper peat, making a nucleus for natural recultivation. In (Table 1) the range is shown for the basic chemical parameters of the upper layer of peat and the bog waters. Values, close to the mean of the natural bog, testify to the resistance of the upper peat to the changes and stability of the natural bog water

The degraded masses are found only among Type II and III bogs. They are characterized by the most profound modifications: total exploitation of the upper peat and the appearance of the lower peat on the surface; expansion of the area of water as a result of the intrusion of groundwaters into the zone of water-changing process.

Because of the non-uniformity of the raised bogs and special features of their development a scheme for their rehabilitation following peat extraction is suggested: self renaturalization (secondary bog forming processes). For the surfaces that have passed through the primary and stages of renaturalization; conversion to forest or agricultural or water conservation.

Self-restoration of the raised bogs by peat-creating process, is a significant reserve for restoration of these unique natural systems.

TABLE 1

Factors	Natural Bogs	Exploited Upper Bog Types		
		I*	II	III
1	2	3	4	5
Chemical Properties of Peat				
pH	2.55-3.44	2.65-3.30	2.65-3.30	2.60-5.75
Hydrolotical Acidness mg-equ/100 g	72.40-190.30	88.20-140.9	106.7-122.30	29.70-127.2
Ash-content, %	2.22-5.55	1.29-5.45	1.19-5.85	1.35-16.33
Absolutely dry substances R_2O_5%	0.20-1.12	0.27-1.34	0.27-0.97	0.25-4.61
CaO	0.13-0.90	0.08-0.97	0.21-1.16	0.38-5.18
N	0.44-1.78	0.85-1.41	0.54-2.45	0.98-3.20
Chemical properties of water (in mg l^{-1})				
pH	3.14-4.65	3.45-4.70	3.95-7.31	4.85-6.48
HCO_3^-	trace-26.8	4.9-24.4	6.1-187.9	12.2-156.2
SO_4^{2}	10.3	2.1-28.0	9.9	4.9-31.3
Cl^-	1.1-13.6	1.5-9.1	3.2-12.2	7.0-9.2
Ca^{2+}	8.4	1.8-4.6	2.4-42.3	2.8-40.9
Mg^{2+}	0.2-3.2	0.7-2.7	0.4-17.6	1.6-11.7
Na^+	0.4-2.8	0.5-2.5	0.4-4.4	1.0-1.6
K^+	0.2-2.4	0.5-2.5	0.3-3.0	0.3-2.7
Total mineralization	11.4-51.4	20.3-51.0	17.5-264.6	32.0-234.3

* Genetic types of upper bogs: I = self-upper; II = upper passed through the stage of lower and transitive; III = upper passed through the stage of lower and transitive developed on silts.

PHYTOCENOTIC ACTIVITY OF WILD-GROWING CEREALS INTRODUCED ON DRAINED SOILS OF SOUTHERN KARELIA

G.F. Laidinen and S.I. Kalinina
Institute of Biology, Science Centre of Karelia, Russian Academy of Sciences, Petrozavodsk

The development of stable and controlled agrophytocenoses on drained soils of Karelia is of considerable scientific and practical interest as is a comparative phytocenotic analysis of a natural and a seeded meadow. In the course of the study of vegetation growing on islands in Lakes Ladoga and Onega, uplands, swamps and riparian meadows were discovered with different levels of development. Species abundance in meadows near Lake Ladoga is higher (19 to 44 species) than that of Lake Onega (14 to 24 species). Cereals in these phytocenoses amount to 30 to 90% (of standing cover); leguminous 2 to 35%, sedge 2 to 30% and herbage 7 to 50%. In a group of cereals valuable forage crops such as *Dactylis glomerata L.*, *Phleum pratense L.*, *Alopecurus pratensis L.* are dominants and polycomponent grass stands are co-dominants. *Phalaroides arundinacea* (*L.*) *Rausch.* forms thickets.

In southern Karelia, under different ecological conditions, the dynamics of species (community) composition was studied for six species produced from the seed of an Island cereal population. These were studied on drained and mineral soil. The field was used twice - the main cut (at the beginning of flowering). After cropping a full mineral fertilizer $N_{60}P_{90}K_{120}$ was applied. It was found that phytocenotic activity of the cereals under study, in the early stages of agrocenoses formation, was conditioned by the rate of seedling appearance. In the second year of the study the abundance of species with fast-germinating seeds was marked, and was independent of soil-climatic conditions. Meadow fescue, red fescue, timothy and meadow foxtail accounted for 60 to 93%, while slow-germinating cock's-foot grass and *Phalaroides arundinacea* accounted for 22 to 56%. Invading cereals and weeds become components of the grass-stand.

Herbage is represented by annual species and is quickly replaced (in 2 to 3 years) by cereals from the agrocenoses. A group of invading cereals on peat soils is represented by 10 to 15 species, with fluctuations of 2 to 11 species in separate years. On mineral soils the invading cereals were represented by 6 to 8 species, with fluctuations of 3 to 7 species in different years. Succession on peat soils is going on faster than on mineral soils. In the early stages of agrocenoses, Devil's grass is a co-dominant with the seeded types and becomes a dominant within a few years. In densely rooted cereal seedings it remains a co-dominant, while in lightly rooted seedings it becomes a dominant. Among cereals always present in cenoses are timothy grass, creeping bent grass, meadow grass (*Poa pratensis*), *Poa palustris* or *P.vulgare*. Their abundance however, is less than 10%. Species fluctuations are important on peat soils.

On peat soils as field age increase all seeded cereals decrease in abundance,but this decrease is not consistent. Red fescue grass, Xeromesophyte, turned out to be the most

competitive, independent of weather conditions. Their abundance is very high even in the 6th year (52%). Mesophytes gradually decrease in abundance in the 5 to 6th year: cock's foot - 20%, timothy grass - up to 13%, meadow fescue grass up to 3 to 4%. But cock's foot grass, on peat soils, has low winter resistance and may completely disappear from the grass stand in any year. The compatibility of meadow foxtail a hydrophyte, is determined to a large extent by rainfall conditions: with a lack of precipitation the species abundance quickly decreases for foxtail in the 3rd year up to 9% and for Phalaroides in the 5th year up to 10%. In favorable seasons the number of species in seeded fields remains rather high; foxtail in the 5th year is 50%, and *Phalaroides* even in the 7th year is 54%. On mineral soils the compatibility of mesophytes is higher, while that of hydrophytes is lower than on peat soils.

Local wild-growing cereals may be used for the development of stable agrocenoses on different soil types. Meadow foxtail and *Phalaroides arundinacea* are recommended for wet areas in mono-specific seedings. Cock's foot grass, timothy grass and meadow fescue grass in mono-specific seedings are short-lived and it is better to introduce them in mixtures. Red fescue grass promotes the formation of a firm root mat and may be used in grass-mixtures. In solving recultivation problems it is recommended to conduct seed gathering from polycomponent cenoses.

ON THE PROBLEM OF RECULTIVATION OF SANDY TECHNOGENIC AREAS IN THE NORTHERN ZONE OF TYUMEN REGION

L.F. Loginov, A.V. Mikhailova, and S.I. Zarubin
Institute of Agriculture, Tyumen

On considerable areas of the west-siberian oil and gas-bearing region the drilling pads are located on natural or elevated sandy ground. Upon completion of drilling the need arises for recultivation of these sandy grounds. The methods of recultivation of sandy technogenic areas have a specific technogenic solution. It is of interest to stimulate natural revegetation of these areas including drilling mud substrates with a grass cover.

The utilization of drilling mud substrate, requires small changes in the organization of the drill site by stripping (uncovering) productive sandy layers and, finding some optimum substrate with the proper physical and physico-chemical properties for the development of plants, and finally, choosing their species composition.

In this connection laboratory investigations were carried out with the aim of determining the influence of drilling mud substrate on the germination of grass seeds and the development of germs. In experimental modelling the seeds of dandelion and red fescue grass are used (Table 1).

TABLE 1
The Study Of Gemination Of Seeds Of Dandelion (D)
And Red Fescue Grass (RF) On Drilling Mud Substrate

Substrate	Germination of Seeds in %							
	in 7 days				in 17 days			
			Mixture				Mixture	
	D	RF	D	RF	D	RF	D	RF
Sand (control)	94	92	56	78	94	95	66	100
Drilling Mud	13	68	6	76	74	93	51	78
Sand + Drilling Mud (1:1)	5	76	33	88	66	92	63	98

D = dandelion; RF = red fescue

The results obtained indicate that germination of dandelion seeds is retarded on the drilling mud as well as on the mud-sand mixture. The retardation is especially noticeable during the first 7 days of germination. To a lesser degree this retardation is seen in the germination of red fescue grass seeds on the different kinds of mud substratum. On the 17th day after germinating the vigor of red fescue grass is practically the same on all kinds of mud substrate. The mixture of seeds of dandelion and red fescue grass (1:1) is characterized by low germinating rates on the substrate studied.

These observations on the growth and development of plants showed no changes or variations (coloring, form, etc.) in plants growing on the drilling mud or on the mud-sand mixture. The normal germination of seeds and the growth of grass on mud substrate permit us to recommend them as meliorants on sandy ground for the recultivation of technogenic areas.

NATURAL RECOVERY OF PLANTS IN ARCTIC TUNDRA

M.A. Magomedova, L.M. Morozova and A.V. Stepanova
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Yekaterinburg

Geobotanic study of areas with disturbed primary vegetation was conducted in 1989 in the Kharasavey settlement and its environs. The floristic analysis showed that the list of flowering plants on all the areas studied includes over 30 species of higher plants. Grasses (*Poaceae*) are especially broadly represented. Cereals are widespread on dumps, elevated areas and in the areas of tundra disturbed by tracked vehicles. The most common cereals are *Alopecurus alpinus*, *Poa alpigena* and *P.arctica*, *Deschampsia obensis*, *D.borealis*, *Festuca*

kriophila, *Calamagrostis neglecta*, and *Phypsia algida*. In more moist habitats *Dupontia fischerii* is abundant. The next most common, based on the number of species, is the family *Astraceae* with 4 genera and 6 species. Of greatest abundance is *Tanacetum bipinnatum*. Individual plants of *Senecio arctica* and *Artemisia tilesii* are common. The family *Cyperaceae* is represented by two genera and 5 species. The most commonly found are *Carex stans*, *C.arctisibirica*, *Eriophorum madium*, *E.polystachion*. Other families are usually presented by 1 genus. On eroded areas *Pumex arcticus*, *Saxifraga cernua*, *Ranunculus pigmaeus*, *Arabis septentrionalis* and others are found.

The floristic list of mosses includes 26 species, and of them 7 species (almost 25%) are typical on disturbed soils. They are *Leptobryum piriforme*, *Ceratodon purpureus*, *Philopilum eaevigatum*, *Funaria arctica* and others. *Ceratodon purpureus* is cosmopolitan. Mosses are often found in the streets of settlements, on road embankments and on other disturbed areas. The moss covering on the disturbed areas ranges from 1 to 5%. In places where the original plant communities partly remain, for example, on areas of sewage or those that have not been completely disturbed by vehicles, etc. All mosses are usually represented by widespread Arctic species. Lichens are found only in areas with fragments of original vegetation. They are absent in serial communities of recovery successions.

It can be concluded that the recovery of plant cover in the arctic tundra zone goes on at the expense of the local flora. In areas with good drainage and light soil - *Deschampsia borealis*, *Alopecurus alpinus*, *Duponthia fischerii*, *Poa alpigena*, *Artemisia tilesii*, *Senecio arctica* are pioneers in the revegetation process. In places with increased moisture-accumulation or impeded drainage bogging-up takes place and *Carex stans*, *C.rariflora*, *Eriophorum polystachion*, *E.medium*, *Rumex arctica* are the dominant plants. The most resistant to pollution by fuel and lubricating materials are sedges, alpine foxtail , buttercup and *Arctophyla*. Disturbances caused by constant mechanical transport of scrap metal and other debris and rubbish, clay mortar and cement from drill sites prevent natural recovery of plant cover and the recovery of original communities is not expected in the near future.

RESTORATION OF MENYANTHES TRIFOLIATA STOCK AFTER STORAGE

T.A. Maksimova and V. Yudina
Institute of Biology, Petrozavodsk, Karelia

Experiments were conducted between 1975 and 1982 on the *Sphagneta obstusi+S.jensenii* from the bog "Nenazvannoe", situated in the southern part of Karelia.

The following conditions of plant storage were imitated (versions of the experiment): I - annual harvest of leaves; II - harvest of leaves in a year period; III - control (no harvest of leaves); and IV - harvest of leaves every two-years. Each version included 15 m^2 sites. During the period of the maximum leaf phytomass production (the 3rd decade of June and

all of July) descriptions of the vegetation, calculation of the number of shoots and leaves were conducted on the sites according to the experimental design.

The investigations showed that during the first three years in all the three versions the harvest frequency of leaves does not essentially influence the phytomass. The decrease of the productivity occurs in the fourth year, but the quantity of shoots and leaves on the site does not change significantly. However, there is a decrease of the weight of leaves per shoot. Because *Menyanthes* (buckbean) is a long-root plant, the experiment was repeated according to the same scheme between 1977 and 1982, but the size of the sites was increased up to 4 m^2. While conducting this experiment the degradation took place earlier. A decrease in phytomass of leaves was noted in the third year.

The storage interval of one and two years is not enough for the complete restoration of *Menyanthes trifoliata* stock on either the 1m^2 or 4m^2 sites. Judging by the rate of growth of *Menyanthes trifoliata*, it takes 3 to 5 years in the southern Karelia for the process of restoration to be completed. In connection with the above in order to preserve the stocks of *Menyanthes trifoliata* it is necessary to alternate the places of storage so that one and the same place (site) was exploited in 3 to 4 year intervals. Proceeding from this, the volume of annual leaf harvest should not exceed 1/4 of the standing crop .

Separation of *Menyanthes trifoliata* leaves in the process of storage led to certain changes of the structure of its population. Under conditions of annual leaf harvest from the 4m^2 site in the 6th year the biomass of leaves of one shoot decreased from 855 to 376 mg (the power of influence is n^2 = 35%), the number of shoots however increased from 118 to 376 (n^2 = 29.1%). The number of shoots in these cases increased from 115 to 154 (n^2 = 34.8%) and from 110 up to 161 (n^2 = 12.2%) respectively.

Thus, under the influence of regular harvest of leaves of *Menyanthes trifoliata* the shoot phytomass, as a rule, decreases while the number of shoots increases.

ANTHROPOGENIC SUCCESSIONS OF PHYTOCENOSES IN DIFFERENT NATURAL NORTHERN ZONES OF WEST SIBERIA

N.G. Moskalenko
All-Russia Scientific-Research Institute on Hydrogeology and Engineering Geology, Moscow

The author for many years (1962-1990) conducted research on the dynamics of plant cover in different oil-bearing regions of Siberia as a member of expeditions of the All-Russia Research Institute on Hydrogeology and Engineering Geology. These studies included: repeated mapping of plant cover by using satellite and aerial photographs made during flights in different years, and by the use of materials derived from ground observations of the key-sites; annual detailed geobotanical description at permanent sites in natural and

disturbed areas; the study of the composition, aquatic-physical and chemical properties of soils, soil-forming rocks and the dynamics of their seasonal thaw. These studies have shown the stages of anthropogenic successions in different natural zones and subzones of the region.

In all natural zones anthropogenic successions are taking place most quickly on flat, bogged watershed plains and on floodplains. Here they are usually developed from the stage of pioneer-grasses (cereals-cotton grass) through the stage of complex grass-moss groups (cereals-cotton grass-mosses) in the direction of communities close to the initial (natural) state.

For communities with a predominance of grasses and mosses the duration of succession is between 10 and 20 years. For example, herb-reed grass meadows on the flooded lands of the south tundra subzones may be recovered in 10 years. The recovery of flat non-complex cotton grass-sedge-sphagnum bogs in forest-tundra and northern taiga occurs within 20 years.

Anthropogenic successions in drained plains consisting of sandy deposits are very slow. Successions on these plains start from pioneer herb groups (cereals) which in the subzone of typical tundra exist during the first 10 years. During the same period in the south tundra subzone and in forest tundra the pioneer groups are replaced by complex herb-mosses groups, which in the northern taiga give way to birch herb-moss communities. On drained sites of the northern taiga, made up of sands, and which before disturbance were covered by birch-pine shrub-green lichen open forest are characterized in the first stage of anthropogenic succession by sedge-grass groups. In 5 years they give way to complex sedge-grass-politrichum communities which, in 15 years, change to birch sedge-shrub-lichen politrichum. In 30 years mixed shrub-grass-politrichum-lichen communities have developed which differ from the initial (state) by the composition of moss-cover (dominated by politrichum mosses) and a wood layer (prevalence of birch instead of coniferous species). These investigations showed that the rate of plant cover restoration of the region increases from North to South and from well drained plains to flat boggy areas.

As a result of generalizing materials on anthropogenic dynamics of the plant cover in different northern zones of west Siberia, it was possible to subdivide (the area) into districts (regions) according to the rate of plant cover recovery after disturbance. The map of natural complexes worked out in the Institute serves as the basis for mapping for such district-division. Three types of regions were singled out on the map-scheme of plant-cover recovery according to the rate of plant recovery. For separated hills and plains the estimation of plant recovery rate was given separately for positive and negative relief forms.

Small-scale recultivation subdivision of the north of west Siberia was conducted on the basis of the map of natural complexes and the map-scheme of plant-cover recovery after impulse disturbance. The data obtained on the plant cover recovery after impulse disturbance were used in making a map of nature-protection regions in the geological environment of the

west-Siberian oil and gas complex. This map served as an initial base for development of a territorial complex scheme of nature protection.

THE ANALYSIS OF THE METHODS OF RECULTIVATION OF THE DISTURBED LANDSCAPES

V.E. Nikolenko
Science and Research Institute, Donetsk

The development of the network of industrial complexes leads to the disturbance of the landscape structure, the composition of soil and its contamination. In order to prevent the disturbance and to restore the exploited lands the process of recultivation is carried out.

With regard to the sites that have undergone erosion the following recommendations are made: 1 - to place granules of an earth-grass mixture on the slope surface, 2 - to place sheets with seeds in a frozen medium, 3 - to place sheets with seeds on the top of the snow, 4 - to apply a protective covering of fertilized soil with seedlings, and 5 - to apply a light and waterproof covering to the surface in order to protect it from snow and rain. With regard to disturbances produced at gas industry sites, it is necessary to employ special methods in producing a vegetation cover, that can substitute for the natural moss-lichen covering.

The process of seeding and reseeding of grass and the planting of bushes should include lime together with organic and mineral fertilizers. For recultivation it is recommended to use introduced (non native) crops such as *Festuca rubra* species, *Poa pratense*, *P.repens*, *Alopecurus pratense* and others. However, the substitution of grass associations for the natural moss-lichen covering disturbs the natural interactions in the biocenosis. Analysis of the Russian and foreign literature indicates that methods for the regeneration of the moss-lichen cover have not been studied. Yet such investigations are necessary for restoration of the disturbed natural landscapes of the North.

DEVELOPMENT OF AN AGRO-TECHNICAL APPROACH TO BIOLOGICAL RECULTIVATION IN THE TUNDRA ZONE

E.V. Overina
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

Biological recultivation is a step in soil recultivation that takes place after technical recultivation and includes steps in the re-establishment of fertility. To study biological recultivation it is necessary to determine the response of the vegetative community to

different agrotechnical backgrounds (doses, time, different ways of grass seeding, grass species variations).

Since 1986 we have been conducting experiments on biological peculiarities of growth and development of highly productive cereals in multi-species, three-layered agrocenoses. the grass mixtures were composed of species with compatible growth, but differing by size (height), root system location and other responses to the environmental conditions. While designing multi-species seedings, the principle of spatial and temporal niches was taken into consideration (Mirkin, 1986). The cereals used were reed canary grass, a long-rooted hydromezophyte; meadow foxtail (tall) a short-rooted, loose-bushy eumezophyte, and meadow grass, a low, long-rooted eumezophyte. Banding, row, parcellar and mixed methods of sowing were studied. The experiments were made according to L.U. Nomokanov's method (1980). The plot size was 5m x 4m with 400 seeds per m^2 in the relation 1:1:1:1.

In the third and fourth years of growth the percentages of the cereals was between 82 and 94 percent of the whole mass of the grass stand. *Regneriy* appeared to be less competitive, but meadow grass showed a good competitive capacity. According to our 5 year cycle of observations the three components of the grass mixture, namely reed canary grass, foxtail and meadow grass form a stable productive agrocenose in the third year. In the fifth year these three species retain a high density of offshoots (tillers) with a high percentage of generative ones, for example, the number of generative offshoots for reed canary grass ranges from 31 to 107 and vegetative offshoots from 268 to 395; for meadow grass the fine roots are between 383 to 833 and from 369 to 1170 respectively. The total productivity in different types of grass seeding varies from 75 to 94 c. per ha of dry mass.

The data show that in the third year of growth cereal grasses contribute much to the process of sod-formation and that the phytomass increases the process of substrate enrichment with organic substance.

PECULIARITIES OF THE FOREST REGENERATION PROCESS ON TECHNOGENIC SITES OF SPRUCE FOREST LOGGING IN THE EUROPEAN NORTH

Yu.A. Pautov
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

Concentrated forest cuttings are a major factor in the anthropogenic transformation of forest-vegetation cover. In the last 50 years forest cuttings were made on almost 20% of forest-covered area of the European North. The degree of transformation brought about by timber-cutting depends on the technology used, patterns of wood-cutting areas and the cutting period or duration. Within any cutting area three technogenically conditioned types of environment may be distinguished:

1) areas without the influence of technogenic equipment on soil ("stripes" and bee-garden sites with preserved young growth of coniferous species);
2) areas with moderate technogenic impact in which tree species are destroyed, over-soil cover and litter (shaking trail) are disturbed;
3) areas with strong technogenic impact on which the vegetation cover is disturbed, the litter is mixed with the mineral part of soil (hydraulic shaking trails, loading areas, roads for timber transportation, etc.).

Especially strong negative impacts of clear cutting are apparent in spruce-forests (with *Hylocomium*, *Dicranum* and *Rhytidiadelphus*) on loamy soils. At present such forests are the basis of the wood-cutting industry of the European North. Analysis of large-scale aerial photography, covering 12,000 ha in the Komi Republic, has shown that even in traditional wood-cutting technology where young growth is preserved the area that has been technogenically transformed amounts to 26 to 48% of the forested territory. In the logging area where the feller-buncher machines are used the degree of technogenic impact increase 1.5-2 times (Rubtsov, et al., 1985).

The dynamics of forest regeneration are determined by the type of cutting micro-environment. On bee-garden sites the litter, over-soil cover and young growth spruce-trees play the role of a source of edapho-cenotic structure of the cut spruce forest. On technogenic sites this matrix or source is disturbed which causes microsuccessional vegetation changes which have a natural spatial-temporal character. The main component of these changes is the competition between pioneer species and sprouting revegetation by leaf-bearing species. this leads to a spatial interruption of the formation of young growth. This is brought about or related to the different types of technogenic impacts on the edapho-cenotope and by the location of the sources of sprouting revegetation. Self-seeding of leaf-bearing species takes place on areas with mineralized litter on the shaking trails. Here birch-aspen young growth occurs under the canopy of which the establishment of spruce-tree is taking place.

On areas with strong technogenic influence expansion of grassy vegetation and soil soding is observed. In micro-depressions haircap-moss and *Sphagnum synusia* develop. Self-seeding of spruce is poor due to a lack of seed sources and unfavorable conditions for germination and rooting of seedlings. As a result on the technogenic areas leaf-bearing young growth of low-density and low-productivity develops. For regeneration of coniferous species it is necessary to leave spruce seed clumps or create forest cultures.

PROSPECTIVE GRASS SPECIES FOR RECULTIVATION OF DISTURBED LANDS ON YAMAL

Yu. F. Rozhdestvensky
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Yekatherinburg

The role of plant cover and the high degree of its vulnerability (to disturbance) in the North are well known. It may be destroyed as a consequence of natural processes but these natural disturbances become relatively unimportant when man influences phytocenoses.

Self-recovery of tundra plants takes place unevenly and not simultaneously. Some plant communities practically do not recover. For example well-drained areas with little soil moisture that suffer anthropogenic influence are subject to wind and water erosion and the revegetation process is very slow. The influence of man on the soil-plant cover can result in a substratum which is very poor in nutrients, often with a low moisture holding capacity and in certain cases with a content of toxins.

During investigations of drilling sites on Yamal peninsula, between 1988 and 1990, four zones of soil-plant cover disturbances were identified. I - the zone of complete destruction; II - the zone of heavy disturbances in which the soil horizons cannot be distinguished, but their components remain; vegetation is destroyed; III - medium disturbance, showing up as spots of different form and size. The primary vegetation is strongly disturbed or completely destroyed. The soil horizons are partly mixed; IV - the zone of weak disturbance caused by single vehicle transport passes. In zone II on flood plains and in zones III and IV on flood plains and on watersheds, plant cover appears after some definite period of time. However, in zone I and, partly in zone II, in order to achieve landscape stability and prevent erosion, it is necessary to create an artificial plant cover.

The tasks of selecting a plant assortment for recultivation of disturbed lands on Yamal were solved simultaneously in the towns of Salekhard and Labytnangi, Tyumen region. Collection and seed areas were laid out and experimental plots were established directly on the territories of the oil and gas fields - Bovanenkovo, Kharasavei, Portovsky, as well as on Kamenny Cape. All in all there are over 200 plots. Over 20 grasses and grass-mixtures were tested including those from other regions *(Deshcampsia borealis, D. caespittosa, Festuca myuros, F. myuros "Shirokorechenskaya", F. myuros "Sverdlovskaya-37", F. ovina, Poa pratensis, P. pratensis "Kirshinsky", Bromus inermis, B. arvensis, Phalaris arundinacea* (local)and from the Komi Republic, *Phleum pratense, Elymus sibirica, Calamagrostis langsdorfii and others).* As local, we consider plants growing on the territory of the Yamal-Nenets autonomous region. Their seeds were collected in the Polar Urals, in the flood-land of the Ob River and in the environs of Salekhard and Labytnangi. Seeds were received from other regions such as Sverdlovsk (Yekatherinburg), the Syktyvkar region, the region of St. Petersburg as well as from Yakutia and other areas.

The testing strategies included different soil composition, fertilizer application rates and using different seeding techniques. It was found that in recultivation work the use of mineral fertilizers should not be excessive as the excess may get into the waters of rivers or lakes valuable as fisheries, and may cause harm. We consider it sufficient to introduce mineral fertilizers on disturbed lands in the amount of 60 kg as active matter per 1 ha only in case of seeding.

The grass stands of *Poa pratensis* and *Poa alpina*, *Deshcampsia borealis* and *D. caespitosa*, *Festuca myuros* and *F. ovina* showed high frost resistance on the Yamal as well as resistance to trampling by cattle. In most cases their standing cover increased in the second year. Three species out of six species from other regions (*Festuca pratensis, Bromus inermis, Phleum pratense*) were destroyed by frost while *Elymus sibirica*, *Poa pratensis* and *Phalaris arundinacea* developed successfully. Of the local species *Poa annua* and *Agrostis alba* did not stand the test. The following grass mixtures were tested: *Poa pratensis* + *Calamagrostis Langsdorfii*, *Poa pratensis* + *Deshcampsia borealis*; *P. pratensis* + agrostis alba, *Festuca rubra* + *Deshcampsia borealis*, *F. rubra* + *Phippsia*. On the second year they give seeds of rather high quality. The norm of seeding of these grass species should not exceed 15 to 20 kg per 1 ha. Large increases above the seeding norm leads to the weakening of grass stand and eventual disappearance of separate species as well as grass stand as a whole.

THE EFFECT OF DIFFERENT ENVIRONMENTAL FACTORS ON GENERATIVE BUDS FALLING OFF JAPANESE CAMELLIA - A CULTURAL PROSPECT FOR GREENING IN THE NORTH SETTLEMENTS

A.F. Semenin
Institute of Forestry, Ural Division, Russian Academy of Sciences, Yekatherinburg

Decorative plants have not only great esthetic or emotional value but also a health function, raising the spirits and increasing the efficiency of work. It is of special importance for the people living in the northern regions of our country where the short summer and severe cold in winter keep people inside their apartments. Among decorative plants that can create favorable conditions in the interior, Japanese Camellia should play an important role. However, the main obstacle is that the generative buds fall off.

Between 1987 and 1990, the effect of different environmental factors on the process of generative bud fall was studied in the hot-houses of The Botanical Gardens of the Ural Division of the Russian Academy of Sciences.

Intensity of light photoperiods

Decrease in light intensity appeared to have a stimulating effect on generative bud fall in Camellia. In test I/10 natural illumination resulted in the fall of all the buds on all varieties of the plant. In test I/3 natural illumination resulted in fall off of a majority of opened buds

as follows: *Magnoliae-flora* from 32.40 and 38.66%. In control plants at natural illumination in other years of the investigation bud fall was between 1.44 and 2.91%. *Anemonaeflora* bud fall ranged between 65.00 and 62.50% to 23.31 and 8.18% ; for the *H.A. Dawning* species, which was studied for one year only, these figures were between 57.14 and 20.0%.

Extra illumination of the plants with a light intensity of 12.00 lux (without extending the day part of the photoperiod) in the autumn-winter period increased the number of opened flowers: in *Darsii* species by 6.80% and in *Frau Minna Seidel* by 8.67%. But in the following year illumination with an intensity of 25.00 lux decreased the number of opened flowers: in Darsii species by 11.70% and in *Frau Minna Seidel* by 24.74%.

With extra illumination at night (the day part of photoperiod was doubled) of 12.00 and 25.00 lux the number of opened flowers decreased: in *Darsii* species by 4.67 and 18.28% and in *Frau Minna Seidel* by 24.03 and 52.16%. The prolongation of the photoperiod at that time stimulated the vegetative buds. *Frau Minna Seidel* showed significant growth of terratological changes of the corolla which had a negative effect on the development of generative buds.

Mineral nutrition regime

The application of double superphosphate fertilizer led to an increase in the percentage of opened flowers: in *Benni-Karako* species from 61.41 to 64.07% and in 524 *Anemonaeflora* x *Grandiflora alba* from 28.16 to 44.64%. Utilization of carbomid CH_4N_2O resulted in some decrease in this index, but due to the significant increase of vegetative buds, the absolute number of flowering buds in this variant was much higher than in the control. Full mineral fertilizer did not affect the amount of flowering buds.

FORMATION OF MEADOW COMMUNITIES CORRESPONDING TO NATURAL CONDITIONS OF THE FAR NORTH

V.S. Sharashova[1)] and I.N. Chuprova[2)]
[1)]State Agricultural Institute, St. Petersburg
[2)]Scientific-Research Institute of Agriculture in the Extreme North, Norilsk

Plant communities are a combination of plants having complex interrelations. In addition to the struggle for survival in natural communities, there exists a complimentarity brought about by structural organization and species diversity which provide stability over time.

The principle of complimentarity must be taken into consideration in the formation of meadow communities for recultivation. For the formation of stable productive meadow communities it is of great importance to choose the proper components including common and native species. In the process of formulating grass-mixtures the species are used that provide optimal biomass production. The use of species with different ecologies and life

history permits full utilization of the environment and allows for a more uniform establishment of the phytomass.

Based on the foregoing principles 5 grass-mixtures were prepared.

Grass-mixture A. Consists of meadow grass (*Poa pratensis*), meadow fescue grass (*Festuca pratensis*) and meadow foxtail (*Alopecurus pratensis*). Because of differences in plenology, a grass-stand of prolonged utilization is created. Quick growth of meadow foxtail (*Alopecurus pratensis*) and meadow grass (*Poa pratensis*) makes it possible to get forage in the spring.

Grass-mixture B. Consists of timothy grass (*Phleum pratense*), Hungarian brome grass (*Bromus inermis*) and meadow fescue grass (*Festuca pratensis*). This combination of middle and late ripening species makes it possible to get phytomass later, thus the pasture period is lengthened. After cutting meadow fescue grass (*Festuca pratensis*) provides good leaf biomass. The addition of regneria, which is more draught-resistant, provides crops (forage).

Grass-mixture C. Consists of species included in grass-mixture B with the addition of reed canary grass (*Gramineae*) which increases the productivity of the grass-stand.

Grass-mixture D. includes meadow fescue grass (*Festuca pratensis*), canary grass (*Gramineae*), and Hungarian brome grass (*Bromus inermis*). This grass-mixture is designed for hay-making and produces well developed layering. The first layer is 110 cm high; the second one consists of vegetative shoots of meadow fescue grass (*Festuca pratensis*).

Grass mixture D. is composed of species of grass-mixture A plus white clover (*Trifolium repens*) and field trefoil. This mixture produces a grass-stand with very high nutrient status. The grass stand has 3 well-developed layers; the first layer includes generative shoots of meadow foxtail (*Alopecurus pratensis*) and meadow fescue grass (*Festuca pratensis*) - 100 cm high; the second layer includes pod-bearing plants (*Leguminosae*) and vegetative shoots of meadow fescue grass. The third layer consists of meadow grass shoots (25 cm high). This grass stand was most productive, yielding from 3 to 5.5 tons of hay per ha.

THE INITIAL STAGES OF THE SUCCESSIVE RESTORATION OF CLEAR-CUT AREAS OF KOMI

G.K. Slusarenko
State Committee of Nature of Komi Republic, Syktyvkar

The following are results of a study of plant life in clear-cuts of sphagno-type spruce-forests, conducted by the author in the Madga forestry of the Kortkeros region. The native sphagno-type forest is characterized as follows: the tree stock is comprised of 8E2B, the density of crowns is 0.5, the age of the spruce trees is 120-150 years, and the birches are 80-

90 years old. The undergrowth is sparse consisting of mountain-ash and spruce, up to 3000 trees per ha with an age of 30 years, in satisfactory condition. The grass-shrubbery cover has been thinned-out and the total standing coverage is 10%. Cranberries and blackberries predominate in the vegetation coverage (up to 10%), these are mixed *Carex globularis* and *C.nigra* (up to 5%), *Equisetum silvaticum* (up to 70%), *Rubus chamaemorus* (up to 3%), *Linnaea borealis* (up to 3%), together with individuals of *Chamaedaphne calyculata, Ledum palustre, Vaccinium uliginosum, Oxycoccus quadripetalus.* Moss cover dominates the microculture and consists primarily of sphagno-mosses: *Sphagnum flexuosum, S.nemoreum, S.fallax,* and *S.russowii* (100%). Green mosses attached to the trunks of the trees and to the base of the stumps comprise nearly 70% of the cover. Among these are *Pleurozium schreberi* (up to 60%), *Dicranum polysetum* (up to 20%), and *Hylocomnium splendens* (30%).

According to the technology of continuous concentrated clear-cutting, the forest sites are divided into allotments and portages characterized by various degrees of disturbance of the upper part of the soils. On the allotment the undergrowth and saplings remain, but nearly 40% of upper soils (horizons) have been ruined. Large changes have taken place in the grass shrubbery cover: blackberries and cranberries remain in up to 3-5% of the coverage. The remaining bushes of blackberries and cranberries have been broken, the leaves have turned purple and rolled, and *Linnaea borealis*, and *Equisetum sylvaticum* are distressed. On the portages the trees have been completely destroyed.

After the tree stock is removed, the plant growth of the clear-cuts experiences a greater degree of insolation and light, there is a decided increase in temperature fluctuations in the lower air and in the upper soil layers, and the wind velocity is increased. On the allotments the growth of light-loving plants increased. Especially luxuriant growth was noted for *Carex globularis* (up to 20%), *Rubus chamaemorus* (up to 5%), *Deshcmpsia caespitosa* (up to 10%). Narrow-leaf willow herb and well-propagated cotton grass also appeared. The moss cover dried out measurably, especially the sphagno-mosses and the erect cover has been reduced by 60%. Among the green mosses such as *Pleurozium schreberi* there was a reduction of up to 50%, *Dicranium polysetum*, up to 20%, and *Polytrichum juniperinum* appeared and accounted for up to 15%. Thus, in the fringe areas of the allotment success will be realized through the use of substitute types of plants, those predominating in the plant life of the native forest.

On the portage the plant life on the recultivated lands takes several forms, among them cranberries, narrow-leaf willow herb, *Carex globularis, C. nigra, Juncus bufonius, Rubus chamaemorus, Eriophorum gracilei* predominate. Newer specimens of moss cover consist of *Polytrichum juniperinum, Aulacomnium palustre, Sphagnum russowii*, and *S.fallax*. On the outer fringes of the portage, the restoration of the vegetation is proceeding by autogenic means.

The propagation of tree growth begins in the following year (after cutting) concurrent with the growth of grasses and mosses. Birches appear by self-seeding on the portages away from the forest wall. Spruce is renewed, if the cutting was done one year before seed fall or the

year of harvest. On the allotments the birches grow more intensively than the spruce trees. Thinnings after cutting of the basic tree stock are subjected to wind forces.

Thus, we may say that for the reforestation in the region in question there is evidently some measure of success: on the portages there is a predominance of autogenic succession of more tolerant types of growth (Hastyer, Mirkin, and others), on the allotments there is a predominance of allogenic succession in the form of an increase in light-loving plants.

RESTORATION OF THE VEGETATION OF TECHNOGENIC LOCATIONS ON THE CHUKOTKA PENINSULA

O. Sumina
State University, St. Petersburg

An analysis of the natural restoration of the vegetation of those areas, subjected to technogenic disturbances, affords the necessary data for the planning and continuation of work on the biological recultivation of the areas in question. The character of the ongoing disturbances defines both the potential for natural changes in the vegetative cover as well as the consequences of the various anthropogenic influences.

The disturbances which have led to the complete destruction of the soil-vegetative cover (mines for the extraction of gravel; sites stripped for various other purposes; sites where the upper layers of earth have been removed by bulldozers, etc.) have been studied. In such places the vegetative process is in the first stage of succession. The substratum which earlier had never been subjected to the influences of living organisms, is now being incorporated into the soil covering. Soil samples were gathered from the regions of the villages of Egkvekinot and Iultin (Chukotka).

It has been shown that flowering plants are of greatest importance in the revegetation of the technogenic locations (TL). Sporous plants comprise no more than 1/4 of the overall plant species to be found on such areas and their standing cover as a rule, is not large. It is remarkable that in 65% of the samplings no lichens were observed. Only 7 forms of flowering plants can be found on the TL's in quantities greater than 40%.

A classification of all the groups of vegetation found on the TL's has been made. The use of the principles of dominance did not give satisfactory results. Such a method defines a large number of species, each of which characterizes one area. By classifying according to floral principles, all the vegetative groups fell into 9 phytocenoses. We are learning which (of the 9) can adapt to which of the various substrata and to which types of disturbances. Additionally, we are learning their properties in relation to the various local conditions - the apparent character of the groups is significantly modified from one location to another, such that the plant families often combine into vegetative communities, found within the boundaries of only one TL. This results from the specific ecological conditions of each TL

and the given set of species which can be introduced from the surrounding communities. Thus, the special properties of the plant life of each TL are expressed considerably more than the common properties among the various TL's.

All vegetative communities that are in the TL's are strongly differentiated from the tundra communities, and are seen as unique conditions or in the first stages of succession even though the earliest disturbances took place some 40 to 45 years ago. For the complete restoration of the tundra vegetation (if this is even possible) a considerable period of time will be required.

In the vegetation of the TL there is a peculiar inversion taking place, ie. the flowering and not the sporous plants are playing the leading role on the anthropogenic substrate.

FORMATION OF HIGHLY PRODUCTIVE ARTIFICIAL MEADOWS ON DISTURBED LANDS IN THE ARCTIC

E.A. Tikhmenev
Russia Scientific Research Institute of Gold and Rare Metals, Magadan

Field experiments aimed at the formation of artificial meadows on disturbed lands in the tundra zone resulted in the development of an effective technology for biological recultivation with the application of perennial grasses. The use of this technology makes it possible to create stable grass phytocenoses similar to natural conditions. The following seeds adapted to local conditions were used: *Elymus sibiricus, E. mutabilis, Alopecurus arundinaceus, Bromopsis inermis, Arctagrostis latiforium*. Recultivation of areas disturbed in the process of developing natural deposits or the recultivation of tailing-deposits to prevent erosion gave good results. In addition to being a good anti-erosion control the artificial meadows are excellent pastures for reindeer.

Because of the greater agricultural foundation, the productivity of the recultivation vegetative cover is 1.5 to 2 times greater than on natural areas. Estimation of chemical composition of the biomass by atomic-absorbtion and spectral methods showed the recultivated areas to be completely fit for use as pastures.

Recultivation of disturbed lands in the tundra zone of the Russian North-East is limited by the lack of adapted seeds. The problem can be solved by the formation of a specialized centre of vegetative resources based on one of the farms of the "Severovostokzoloto" corporation, where at present fields with perennial grasses occupy more than 120 ha. The centre can be a steady supplier of seed material for recultivation of disturbed lands in the industrial regions of the Russian North-East.

SPECIAL CONDITION FOR FORMATION OF NATURAL AND CULTIVATED PHYTOCENOSES OF THE YAMAL TUNDRA

V.N. Tyurin
Institute for the Problems of the Northern Development , Northern Division, Russian Academy of Sciences

The study of the principals of the restorative dynamics of vegetation helps in choosing the best ways of conducting biological recultivation, as well as the most successful prediction of the possible consequences of anthropogenic influences on environment.

The study of the special conditions of restoration of phytocenosis was conducted in the area of the Bovanenkovo gas-condensate field situated in the zone of typical tundra on Yamal. Here, artificially cultivated seedings using perennial grasses as well as seeding under natural conditions were observed together.

In artificial seedings 7 plant species were used with 5 species coming from the Syktyvkar Agricultural Experimental Station. All these species can be divided into 3 groups: 1) imported plant species which have no analogues in the region of study (Bovanenkovo) such as lady grass, Hungarian grass, brome grass, meadow fescue grass; 2) imported plant species which have analogues on the territory under study (Yamal) including meadow grass and red fescue grass; 3) local plant species such as alpine foxtail and *Deschampsia sukaczewii*.

The seeding was conducted between 1988-1989. The seeding of local species was done only in 1989. The seeded grasses were observed over 3 years - from 1988 until 1990. Analyses included the time of seedling appearance, the height of plants, erect cover and the time from ripening until the generative stage. The results of these experiments showed that exotic plant species are practically fully destroyed by frost in 2 to 3 years after seeding. Imported species (group 2) and plant populations from the area under study, as well as plant populations gathered on site develop successfully passing into the generative stage in the 2nd or 3rd year.

Taking into account the above results, the use of local plant species should be considered expedient for biological recultivation. This conclusion is supported by observations on natural plant cover recovery, where adventive species are practically never found.

The peculiarities of self-recultivating plant communities are also of interest in choosing a recovery strategy for destroyed ecosystems. In our studies we noted considerable lumping of the dominate plant species in derivative communities, whereas in the background with a considerable species diversity of apophytes, the portion of the most active species in the total flora is a bit more than a dozen. All of them may be divided into 2 groups: 1) Species growing on well drained areas with mineral substratum: lime grass, *Deshcampsia sukaczewii*, narrow reed grass, meadow grass, *Poa alpigena, Poa arctica, Alopecurus alpinus*, red fescue grass, *Tripleurospermum khukeri*. 2) Species belonging to areas with organic substrate

having, as a rule, saturated conditions: *Eryophorum polystachion*, *E. medium, E. russeolum*, sedge. All plant species mentioned can be recommended for artificial recultivation in the typical tundra of the Yamal region.

ANTHROPOGENIC LANDS AND THEIR SOCIAL RECULTIVATION

A.E. Veski
Institute of Chemistry, Academy of Sciences of Estonia, Tallinn

In all probability for the first time man was included into the geographical landscape structure (in papers by) by Grane and Berg, (at about this time Getter doubted that these scientists were ready to recognize man as an object of general agriculture). According to Grane, man is united with the landscape and has an effect on the landscape both directly and indirectly. According to Berg, landscape means an area where the type of the relief, climate, flora, fauna, and finally, the people's culture are combined into one whole.

The next generation of land scholars does not even mention these two classics of the land theory, with Labelin's monograph (1989) being no exception, although the above mentioned paper by Berg is referred to, but in another context. In his later papers Berg himself did not include man in the landscape any longer. Only half a century later did Grane and Berg's ideas become topical again as they helped to achieve a better understanding of man's role in anthropogenic lands. Because plants and animals are include as components in the landscape Man's presence is established on the anthropogenic lands (Veski, 1989). We should agree with Grane who believes that man is always a temporary phenomenon in the landscape, represented only indirectly as a result of his activity.

The recultivation of degraded lands should encompass mechanical, physical, chemical, geological, biological methods or a combination of them. It would be correct to call any recultivation of the land a "social recultiation" , and that it should consider the conflicting mutual influence of the indigeneous peoples and those from outside. It is suggested that this approach to recultivation is most important for land management in the North where people suffer greatly because of unfavorable environmental change (originating from the outside).

RECULTIVATION OF FOREST LANDS AND THE PROBLEM OF INSECTS IN THE CENTRAL PART OF KOMI

E.V. Yurkina
State University, Syktyvkar

Investigations have been conducted on pure stands of pine trees, created on the sites of former active quarries, as well as on the sites of former forest-storages. Over the last 15 years the dynamics of the change in the species composition of the insects, beginning from the time planting of the trees, has been followed and studied. The injury caused by different kinds of insects and their influence on pine trees has been recorded.

In the very first years in the life of the trees the common insects are *Holobius abietis L., Magdalis Frontalis Gyll.; Adelognatha; Pissodes notatus F.; Diprion pini L.; Acantholyda erythrocephala L.; Evetria turionana Hb.* . In trees 10 to 12 years of age, there appeared such kinds as *P. Melolontha, Amphimallon solstitialis L., Evetria, E. resinella L. Evetria turionana Hb., Blactophagus minor hart.*, and *Blastophagus piniperda L.*

Complexes of insects develop from the moment of tree planting and produce an immediate effect on the viability of the trees. Annually about 10% of the trees die because of the insects. Besides tree death, within the stand, there is a marked decrease in net growth, the formation of deformed shoots, bent trunks, "many or polyshootness", trees with the shortened needles of spruce type, etc. Cockchafers play a leading role in the weakening and withering of the trees along plowed furrows in dry pine woods. In trees planted in quarries - *Dioryctria abietella V. pinetella Rods* are also important.

The most important reason for the increase in the number of insects, is sparsity in the tree planting; as a result of this, the forest is not formed for a long time. For example, a number of insect types which do not have any economic importance in natural forest ecosystems, *Hylogius abietis L., Evetria, Dioryctria abietella V. pinetella Rods*, reach the "crucial" number and do a lot of harm in the controlled plantings.

The costs of recultivation of lands disturbed by anthropogenic activity, as a rule, are not covered. Pure cultures of pine-trees are very weak and are not viable and a lot of them die from different diseases and insects because they have not reached the fruitful age. Their planting is not profitable without use of a regional system of the integrated protection.

THE ORGANIZATION OF A SEED FUND FOR THE RECOVERY OF DISTURBED PLANT COVER IN THE FOREST-TUNDRA AND TUNDRA OF WEST SIBERIA

S.I. Zarubin, V.P. Kolmakov and E. F. Loginov
Institute of Agriculture, Tyumen

At present the destruction of the plant cover, the main component of the ecological systems of forest-tundra and tundra biomes of West Siberia, has reached critical levels. Over hundreds of thousands of hectares an Arctic desert is developing that covers areas from five to 150 hectares.

There is no exact information on the areas of destroyed ecosystems. In addition to sites intended for roads, pits and drill sites there considerable areas have developed with destroyed plant cover the result of the use of improper technology in getting building materials (sand for example), non-observance of regulations and directions of transport vehicles and erosion processes. Erosion alone increases the area of disturbed lands by five to 20% every year.

The organizations exploiting gas-bearing territories, do no conduct recultivation works in time. The existing projects on recultivation have serious shortcomings and defects and cannot be accepted as nature-protective, because everything is planned at the expense of neighboring ecosystems. This results in additional areas requiring recultivation. The suggestions for the introduction of high doses of mineral salts (500-570 kg per ha) are ecologically criminal. The species composition of plants mentioned for (recultivation) projects is very poor (one to two species) and in most cases their ecotype does not correspond to the ecotope conditions. In existing projects developed by a number of european organizations the cost of seed material is extremely low. There is no reference to the use of genetic resources (genofund) of plants from the local flora.

The aim here is to develop guidelines for the use of genetic resources (genofund) of local flora for the recovery of the disturbed plant cover of the forest-tundra and tundra zones in West Siberia. To achieve this, a series of tasks were put forward: 1) To identify species suitable for the recovery of plant cover from the genetic resources of the flora of Tyumen region. 2) To determine ways of storing diaspores (propagation structures) such as seeds, buds, tubers, rhizomes, cuttings, spores and others. 3) To determine the cost of the diaspores taking into account the manner of storing them. 4) To develop ways of making seed material cheaper. 5) To determine the need for diaspores of different plants to provide species diversity of 30 to 40% greater than the initial. 6) To develop a classification of ecotopes which come about during the destruction of tundra biota. 7) For each ecotope type to develop grass-mixtures, the total ecological range of which would be greater than the amplitude of the change in conditions. 9) To develop a system of seed supply needed for recultivation of disturbed lands.

All the above tasks have been completed and a monograph published which is the basis for the development of guiding principles on the organization of seed banks for recultivation. The monograph consists of eight parts, and gives complete characteristics of 50 grass-mixtures for all types of ecotopes.

SECTION 3: MECHANICAL DISTURBANCE AND MELORIATION

SOIL-ECOLOGICAL ASPECTS OF AGRICULTURAL DEVELOPMENT OF PODZOLIC SOILS OF THE NORTH

V.F. Basevich and I.B. Makarov
State University, Moscow

Podzolic soils of the North are characterized by low natural fertility which is closely related to the unfavorable heat regime of these soils. The low level of biological turnover and reduced microbiological activity do not promote the accumulation of nutrient elements and formation of mature humus that is resistant to ecological changes. That is why, for the successful development (use) of these soils it necessary not only to foster the development of new organic matter, but also to preserve already existing reserves of soil organic matter, especially its humus part.

Investigations were conducted on podzolic soils of the Arkangelsk region ("Lyavlya-forest") on lands ameliorated after deforestation and sown to perennial grasses. A peculiarity of this area is the different age of arable land related to stage-by-stage deforestation and represented by 2-, 4- and 6-year plots. The soils of neighboring forest biogeocenoses and old arable lands were studied as controls.

The morphological analysis of soils on the territory under development showed that the formation of the arable layer is taking place mainly on the remains of the podzolic horizon, in which there is sometimes in-mixed illuvial horizon material with the partly decomposed remains of timber and roots. Practically everywhere the upper boundary of the illuvial horizon is related to the character and type of amelioration activity. Such proximity of the water table to the soil surface, in spite of drainage, leads to periodic stagnation of moisture in the arable layer which is reflected in the character and degree of soil gleying. These conditions result in the formation and accumulation of humus in soils under study . Carbon content in fields with crops rotations of 2 and 4 years ago is very low ranging from 1 to 1.5% The thickness of the humus layer is, on average, 7 to 10 cm, but in some places the humus is absent. The thickness of the humus layer on a 6-year plot ranges from 0 to 30 cm, which is the result of extremely uneven application of high doses of peat-manure compost (mixture). The soil organic matter is weakly bound with mineral material and is only partly decomposed which shows the weak humification of the introduced compost. Relatively fast differentiation of the humus content of old arable soils reflects the instability of the humus matter in these soils. At the depth of 15 to 20 cm the carbon content, as compared with upper 5 cm, was 0.2 to 0.3% lower only two years after the tilling stopped (with average carbon content of 1.6%).

The process of cultivation proceeds domewhat differently using other indices. Thus the values of pH (KCL) for the 4- and 6-year plots are very close to those of the old arable land. In all cases the decrease of this value (pH) with the depth is marked, on average from

7.0-7.5 to 6.0-6.5. The near neutral medium is evidently related to the rather high, for these soils, content of Ca 4.5 to 5.0 mg.$100g^{-1}$ in the lower part of the developed layer to 15.0 to 20.0 mg.$100g^{-1}$ in the upper part of developed layer. The two year plot is characterized by lower pH (KCL) values (from 4.5 to 5.5) which is similar to virgin variants. An analogous situation is observed for the content of available P and K. The maximum is seen in old arable soils (the upper 20 cm layer contains up to 55 and 40 mg.$100g^{-1}$ P_2O_5 and K_2O respectively); minimum values occur in the 2-year plot (the upper 5 cm layer contains to 6.5 and 7.2 mg.$100g^{-1}$ P_2O_5 and K_2O). The 4- and 6-year plots are characterized by almost the same contents of P and K which are close to the values in the old arable soil. The P and K content increases with the depth in the cultivated layer on a 2-year plot which is characteristic for virgin analogs.

The investigations show that "stress" applied to podzolic soils as a result of severe ecological disturbance is ameliorated rather quickly (4 to 6 years) with regard to nutrient elements and exchangeable acidity. Soils of the 2 year plots remain similar to those of the forest biogeocenosis. The situation with respect to organic matter and its importance in the formation of the necessary level of fertility is more complex. Podzolic soils should be treated with great care in the process of agricultural development in the North.

FLOOD-LAND LANDSCAPES OF THE YAMAL PENINSULA AND DIAGNOSTICS OF THEIR ANTHROPOGENICALLY CHANGED SOILS

F.I. Gafurov
Institute of Plant and Animal Ecology, Russian Academy of Sciences, Ural Division, Yekaterinburg

Flood-land landscapes of the region under study are extremely dynamic, young and open to anthropogenic damage. This imposes certain demands for an estimation of the anthropogenic degradation.

The distinctiveness of flood-land landscapes of high latitudes is the result of their special character ecological history. For example, landscape (micro-landscape) differentiation occurs along horizontal ecological zones (conditioned by alluvial regime) or along vertical ecological zones (conditioned by flood regime). They may be subdivided into drained and non-drained (according to drainage conditions). Thus based on the inter-relation of the three main ecological factors - flood-land conditions (high, intermediate and low flood plains), alluviality (terrace-side, river-bed-side and central bottom land), drainage (drained or non-drained flood-land) it is possible to distinguished up to 18 types of micro-landscapes which differ in their sensitivity and stability to anthropogenic influence.

Within the region under study a group of anthropogenic factors connected with developing and laying out of the gas-condensate field are wide spread. First and foremost is mechanical

destruction of the ground-soils and their pollution with fuel, lubricating materials, gas-condensate and sewage waters.

In determining the degree of landscape disturbance it is necessary to have criteria that would take into account the condition of the biota as well as of the ecotope for an estimation of their self-recovery and recultivation potential. Such criteria include the extent (thickness) of the A and/ or peaty horizon overlying the genetic soil body. Using this criterium three degrees of anthropogenic degradation of flood-land micro-landscapes were are identified:

1) Weak. The anthropogenic disturbance does not destroy the entire genetic matrix of the soil, it only disrupts ("shakes loose") the A or organic horizon. In case of pollution, the disturbance is manifest in changes in soil chemical parameters, but within their natural range and for the plants, in the suppression of life activity of some species.

2) Average. The anthropogenic impact causes local disturbances in the genetic matrix of the soil body that, as a rule, lead to considerable changes in the thickness of the A or peaty horizon. Under mechanical disturbance, for example, the genetic soil horizons may be mixed and many species disappear from the cenosis, with exposure of the mineral. In landscape pollution considerable changes in the basic soil processes occur; for example, an intensification of gleying and oxidation in alluvial sod-deep-glay soils.

3) Strong. The anthropogenic impact causes complete destruction of the genetic matrix of the soil body. As a rule this results in the loss of all of the A and/or peat horizon thickness. In this case separate, undestroyed remnants, of the genetic matrix of soil body may be found, together with bare soil-forming rock.

TRANSFORMATION OF YAMAL LANDSCAPES AS A RESULT OF TECHNOGENIC INFLUENCE

A.A. Gubarkov
Institute for Problems of Protection of the North, Siberian Division, Russian Academy of Sciences, Tyumen

In the area of arctic and typical tundra where permafrost is widespread anthropogenically induced cryological processes became widely developed as a result of intensive technogenic loads. Observations carried-out on these processes in the Kharasavei and Bovanenkovo gas fields between 1988 and 1990.

Track-transport and construction work during the summer periods of 1987 and 88 resulted in a considerable disturbance of the soil-plant cover; in places it was fully destroyed. The transformation of the soil-plant cover leads to changes in the temperature and water regimes within seasonally thawed (active) layer which, in turn leads to an increase in its thickness. The result is a rapid activization geocryological process, especially on slopes. For example, on one of the sites on which construction had taken place (about 1 km^2), three thermokarst pits or basins and three large-landslides were formed. The area of the thermokarst changed

from several hundred to 6000 m^2, with embankment heights of 1.5 to 2.5 m. The development of landslides occurred on slopes with different exposures and inclinations of more than 1.5°. The length of landslides changed from 100 to 150 m to 700 m and the width from 20 to 60 m. The area of surface disturbances as a result of the largest landslide (taking into account shifts and earth cracks) covered more than 12 ha. The volume of dislocated soil reached 14,000 m^2.

After rapid landslides ice melting in permafrost takes place. The melting is accompanied by intensive water outflow that either forms ponds in embankments, swells or linear features or forms ravines as it flows to rivers and lakes. The vegetation in places of landslides recovers very slowly as the exposed soil is salty. Non-sodded slopes are subject to thermoerosion. In the settlement where the well drillers live eight ravines developed with lengths of 10 to 20 m, the widths of 0.8 to 1.5 m, and depths up to 1 m. Two ravines were formed with lengths of 30 to 40 m. The system of ravines had a total length of 120 m.

These data give evidence of a very strong potential for development of induced geocryological processes that become fully apparent in the regions of industrial development. Experiments on recultivation carried out by many scientists and organizations show that in many cases time is required for the induced geocryological to reach a stage of some stability after which the works on recultivation of disturbed territories are possible.

With the increase in the role of the anthropogenic factor and the worsening of ecological situation on Yamal the problems of landscape stability and their transformation as a result of industrial development become more and more important.

THE MANAGEMENT AND METHODS OF RECULTIVATION OF THE EXPLOITED NORTHERN LANDS

L.P. Kapelkina
State Pedagogical University of Russia, St. Petersburg

At present many different kinds of minerals are taken from the Kola Peninsula. The mined areas are characterized by different degrees of environmental disturbance. Waste rock or spoil accounts for 90 to 95 percent of the mineral material. The absence of a fertile soil layer and only a small amount friable fine grained marine deposits make the process of recultivation difficult and of limited extent. The important task in this region is to simplify and reduce the cost of restoration, by using the natural forces of nature where possible.

Waste products from ore washing plants dispersed in the shallow granular soils create the most dangerous ecological problem. The waste products of the enrichment process are marked by very high concentrations of such ecologically dangerous elements as: F, Sr, Zr, Nb, and Y. The waste products of a Apatite ore washing plant are enriched with the heavy

metals Ni, Cu, Cr, and some radioactive elements are found in the waste products of the Kovdor ore washing plant.

Agricultural development of the exploited lands becomes complicated not only because of the presence of high concentration of microelements, but also because of the absence of fertile or potentially fertile soils. With the biological methods of the recultivation of the northern lands of mechanical and chemical stabilization of the tailings are acceptable. Among the acceptable methods of recultivation are: 1) covering (or filling) of the mined-out quarries by the waste-rocks; 2) storage of the enrichment waste in the quarries; 3) use of new techniques in particular the "GT" technique for covering sites, that are difficult to reach, with rock acceptable for biological recultivation.

Recultivation of the disturbed lands on the Kola Peninsula first of all has a social-ecological purpose aimed at the improvement of sanitary and recreational conditions, enhancing the aesthetic value of the landscape, cleasing and removing any damage (pollution) to the environment,primarily on sites close to inhabited regions. The management and methods of the restoration should be chosen on the basis of analysis of the abundant data with the primary focus on the ecological and technical-economic factors.

TRANSFORMATION OF THE FOREST ECOSYSTEMS IN THE NORTH IN THE ZONE OF INTENSIVE FOREST CUTTING

V.B. Larin
Institute of Biology, Komi Science Centre, Syktyvkar

The Komi republic ranks second in forest cutting among all the regions of Russia. During the last 50 years within an area of forest covering 29.8 mln per ha, area of 6.5 mln ha has been cut. In the Udora region the forests covered 3.1 mln per ha and during period between 1968 and 1990 1 mln per ha of them were cut; in 22 years deforestation of the region reached 30%. On a world wide basis woodcutting has never reached such rates. For a number of reasons, both economic and organizational, most of the highly productive coniferous forests are being cut and by 1991 pine forests of the region were almost destroyed.

Because of the intensive forest exploitation soil-vegetation conditions have fully changed. This has destroyed the water balance and hydrological regime of the region. During five years (1983 to 1988) the swamp area in the region has increased by 7,000 ha and deforestation reached 45,600 ha. After woodcutting precipitation, reaching the ground surface, has increased by 15 to 200 mln per year, and evapotranspirations decreased by 20 to 35%. Due to the impact of heavy woodfelling machines the hydrological properties (porosity) of the soil decreased over 25 to 30% of the area.

Technogenic transformation of the forest ecosystems in the northeast of the Komi Republic has reached such proportions that a global change of vegetation has been noted. In secondary forest succession the replacement of coniferous by deciduous forest is either short-time (less than 150 years) or long-time (over 150 years) and is relatively stable, i.e. secondary succession without the return to the primary type (Sucachev, 1972). During the next 200 to 250 years over 30% of the area in the Udora region forests will change and not return to the original type.

Simultaneously with vegetation, fauna and water ecosystems change greatly. The catch of salmon decreased by 12 fold during the last 17 to 20 years in the basin of the Mezen River although serious contamination is absent there this according to the data received in the laboratory of the ecology of water organisms at the Institute of Biology of the Komi research Centre.

Very intensive logging results in great differences between the composition of the native forest and the composition and cleared areas. Between 1983 and 1988 the area of coniferous forests has decreased by 146,000 ha and deciduous forests have increased by 100,200 ha. Every five years areas taken over by young plants increases by 250 to 260 thousand ha. During first 10 to 15 years deciduous plants are dominant among young plants on about 80% of the area.

Technogenic factors thus cause great change in the northern ecosystems in the zone of intensive forest-cutting. Concentrated cutting is accompanied by an ecological and geographic differentiation of the forest ecosystems. Considering the present understanding about the degree of stability of secondary plantings (succession) it would be advisable to change somewhat G.F. Morozov's expression and define forest as a historic-geographic phenomenon.

THE PROSPECTS OF UTILIZING SHALE-BEARING ROCKS IN BIOLOGICAL RECULTIVATION IN THE EUROPEAN NORTH OF RUSSIA

N.S. Lavrenko
Institute of Geology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

Within the northern region of the European part of Russia four shale-bearing regions stand out. The existing resources of combustible shales, their chemical-technological properties and their engineering-geological conditions are favorable for the commercial use of this resource.

The stratigraphic position of the combustible (lignitic) shale allows for open pit mining. The search for and the selection of the most rational and economical technical solution for recultivation of exhausted quarries is now already taking place.

As a result of investigations conducted on combustible shales in the Komi Republic the geology, physical properties and chemical composition were studied and the rare-metal characteristics of the shale-bearing sequence was determined. It was determined that the organic component of the combustible shales is in brown-coal (lignite) phase, and that the content of microelements is high, but is not potentially toxic. It was also demonstrated that the shales have a weak natural radioactivity. The mineral mass consists of clay minerals and carbonates and the presence of pyrite is noted. Experimental work on the direct use of combustible shales and the products of their processing demonstrated that they could be used as organic-mineral fertilizers and meliorants, on acid podsolic soils in northern conditions. The composition and relationship of minerals in the non-organic matrix of shale-bearing (non combustible) rocks is analogous to those of the combustible shales. These litho-types differ only in the content of organic matter, shale-bearing rocks are generally poor in organic matter. In biological recultivation of exhausted shale mining areas non combustible cuttings, together with combustible shales, a small part of which usually gets into dumps, are a good substrate which does not need additional fertilizers. They are weakly lithified and are easily reduced to fragments that rather quickly give way to weathering and hypergenesis and thus enrich the soil with humus.

THE CONDITION OF THE UPPER BOUNDARIES OF THE PERMANENTLY FROZEN EPICRYOGENIC ROCKS IN CONNECTION WITH THE DISTURBANCE OF NATURAL COVERINGS

G.G. Osadchaya, A.D. Sitnikov and M.A. Leonov
Research Oil Institute, Ukhta

In the cryolithic zone of the continental tundra epicryogenic deposits are wide spread. The upper horizons of these deposits, underlie the seasonal thaw layer and are characterized by an increased retention of ice and, consequently, by high values of cumulative moisture content. In the specialized literature this phenomenon is given various explanations. The investigations conducted in the continental tundra, show that the geographic distribution of similar exposures with increased icing (sandy-loam types were observed), as well as, the frequency of their occurrence, on the fringes of certain landscapes, are subordinated to latitude zonality and, to a lesser degree, to longitude, being disturbed on the sites with abnormal temperature in the permanently frozen rocks (PFR). On the sites with similar geological and surface conditions, the absolute values for moisture of the icy horizon can be significantly different.

An attempt has been made to find the reason of these regularities. A model has been developed for the heating conditions of the ground close to the upper boundary of the cryolithic zone under natural conditions and under disturbed conditions resulting from industrial developments. Simulations have shown that the response in this section, which is determined by characteristics of the seasonal and permanently frozen rocks, as well as the type of vegetative cover, was not everywhere. For example when the natural cover was

removed the maximum "heat stroke" is recorded in the zone of continuous distribution of PFR. However, this does not always led to the lowering of the upper boundary of permanent frost. The minimum "heat stroke" is observed in the zone of the discontinuous distribution of PFR and as a rule, this leads to the abrupt lowering of the upper boundary of PFR.

PROBLEMS OF THE PRESERVATION OF SOIL STABILITY UNDER AGRICULTURAL DEVELOPMENT IN THE NORTHERN CONDITIONS

V.D. Vasilyevskaya
M.V. Lomonosov Institute of Soils, Moscow State University, Moscow

Increasing anthropogenic impact on the ecosystems and soils of the North as a result of industrial contamination, prospecting, extraction of useful minerals, and agricultural development of the territory create preconditions for the decrease of their stability. The stability of soils, buffered, open dynamic systems as defined by M.A. Glazovskaya, is understood to be their ability to return after perturbation to this initial state and to preserve productivity in the socio-economic sphere.

Various external factors and properties of soils that influence their resistance to anthropogenic impacts are arranged according to their role in supporting soil stability, and are evaluated by points on the basis of special characteristics or quantity gradation. The total estimation permits the identification of soil groups with various degrees of stability. The main parameters used in defining stability of soil (or soil-vegetation) are the annual sum of temperatures above 10°C, relief characteristics, lithology and granulometric composition of soil forming materials, biological productivity (annual growth), and the intensity and rate of the biological cycle. And, for the permafrost soils, ground ice and the degree of seasonal thaw, their acidity, cation exchange capacity, degree of base saturation, as well as such physical properties as water permeability and structure that play an important role. Agricultural development of the territory and availability of forests are of importance too. This enumeration can (should) be expanded because additions to the number of parameters increases the reliability of the prediction of soil and vegetation stability. The ability to evaluate many of these parameters decreases as the soils and natural vegetation are converted to agricultural production.

The preservation and restoration of soil, especially its biological stability and resistance to erosion in the taiga zone are defined by numerous parameters depending on the character of forest vegetation and the degree of forest cover on the territory. Thus, stability is connected with the biological productivity of phytocenoses, resistance of plant remnants to decay, thickness and type of forest litter, and its chemical composition. If we take into consideration that indices of the primary production of agrophytocenoses in the North are higher than for the taiga ecosystems (Krasovskaya, Alexandrova, 1961), a greater estimation (value) of forest areas in comparison with arable land becomes evident.

The role of large tracts of forest are very important in maintaining the soil's stability against technogenic impact because the purification of intersoil and surficial drainage from nitrates and other contaminants occurs there. Experimental studies have proved that in places where forests are in contact with agrocenoses, products of water erosion and deflation accumulate, and transformation of the natural water composition takes place (Paulukiavichus, 1989). On the northern border of agriculture it is important to solve the questions about optimal areas for the ecological stability of landscapes.

TECHNOLOGY AND TECHNICAL SOLUTIONS FOR THE CREATION OF MACHINES AND EQUIPMENT FOR TERRAIN RECOVERY IN THE ZONE OF CONSTRUCTION OF GAS-MAINS ON THE YAMAL PENINSULA

N.T. Vilenskaya and A.V. Amelin
VNIIST, Moscow

Linear constructions in the extreme North have reached hundreds of kilometers. Modern technology for linear construction (pipeline) can not protect natural complexes such as soil, vegetation, microrelief or underlying rocks from significant impacts. Observations along the gas-mains show that the processes of thermo-erosion, thermokarst, and solifluxion are occurring and will result in irreversible changes to the whole environmental complex.

Research on the interaction among the working complexes and the main components of the landscapes makes it possible to evaluate the range of the disturbances and forecast the rate and consequences of their expansion. A thorough study and analysis of the nature of the regions of the extreme North, in particular, Yamal and the Komi Republic, together with the impact on this region of the construction of gas-mains points out the necessity of preconstruction scientific studies on the ecological optimization of construction technologies.

The analysis of terrain reclamation proved the necessity for the development of special technologies to help solve the problems of gas-main safety through the period of development, during use and subsequently during restoration of the natural complexes. The new technology must secure maximal preservation of the vegetation on the construction line from off-road vehicle movement, and it must be based on retention of the thermal insulation of the soil for simultaneous recovery of vegetation on the disturbed plots.

A considerable acceleration of the processes of landscape rehabilitation results from terrain reclamation focused on decreasing the effects of the technogenic disturbance that produces deep seasonal thawing, landscape restoration and the restoration of proper living conditions for the animal life.

The experience of terrain recovery in Russia and abroad has shown that in order to achieve the greatest affect in reclamation work it is necessary to carry out a sequence of complex technical and biological stages of reclamation and anti- erosional measures. However this

experience does not cover the multitude of possible situations along the line of construction. The main thing that comes from the analysis of experience in decreasing ecological disturbances is the recognition of the necessity for ecological optimization of modern construction technologies.

The main principles of terrain reclamation along the gas-mains in Yamal and Komi Republic have been worked out:

- ecological-technological studies must be made during the building period for ecological optimization of technological processes;
- building of a snow-ice cover in the right-of-way to protect it from damage during construction;
- restoration of the peat layer, mixed with mineral soil, for insulation and preservation of drainage to minimize heaving. For this purpose the previously stripped layer of peat with mineral soil should be used in order to stimulate the production of the vegetation.
- for an accelerated growth of peat-forming vegetation compact-seeding material is recommended.

With such a complex technology, biological restoration can be applied to the area simultaneously with the return of the insulating peat layer in winter. Post-winter introduction of nutrients and seeding material can be made by spray methods and by equipment mounted on stationary frames for use at the vulnerable areas.

In 1992-1993 an experimental station will be built on Yamal on which trials of the suggested technology for terrain restoration and technical solutions for its application will be tested.

GEOECOLOGICAL FEATURES OF SOIL RECLAMATION IN GOLD MINING AREAS WITH PERMAFROST

E.A. Voronchikhina, A.Y. Zaporov, and Ye.V. Borodina
Perm State University

The impact of mining activity on the environment is not limited to the destruction of soil and vegetation, changes of topography, and contamination of air and water basins. Alongside the visual impact there are less obvious impacts, such as the disturbance of the geochemical cycle, heat balance, and the resource potential (natural system) as a whole. Since these less obvious impacts were insufficiently studied during the development, attention was very often given to the restoration of external ecosystem parameters. This resulted in unforeseeable ecological changes hazardous to human life and health.

In 1976 and 1991 the ecological consequences of the development of gold deposits in various natural zones in this country were studied with the aim of their recovery. The present technology for the development of gold deposits is ecologically imperfect. During the

mining the soil-vegetation cover is fully destroyed on the right-of-way area and erosional forces increased by a factor of 2.0 to 2.7. Fine-grained material was carried well beyond the mining region. Such negative ecological impacts, however, are relatively quickly neutralized by natural restoration processes: erosion is reduced, vegetation is restored, and soil formation begins anew. The analysis of natural recovery on the mine tailings showed that when measured by major evaluation characteristics such as species composition, structure, growth and productivity, the post technogenic vegetation is comparable with the natural area. In the heat deficient zones (tundra, taiga) and in permafrost sites recovery can exceed the natural areas in species variety and productivity. This phenomenon can be accounted for by the increase of heat supplied to the substrate as a result of the mining activities.

The high heat potential of technogenic terrains allows them to be considered for the development of meadow-pastures. Examples of such recovery can be found in the Magadan, Irkutsk, and Krasnoyarsk regions. Such recovery is not difficult to make, and it involves the modification of relief, adding soil and of sowing grass. The expenditures are in the range of 3 to 8 thousand roubles per ha (1991). Nevertheless, the prospects of the agricultural utilization of dumps seems doubtful, since one of the major ecological results of the mining activity, the accumulation of toxic micro-elements by vegetation, is not taken into account. The study of the chemical composition of the phytomass from the reclamation sites and naturally recovering vegetation showed the presence, in high concentrations, of heavy metals that are dangerous by the accepted standards.

Thus the involvement of heavy metals into the biological cycle above normal doses is one of the main ecological consequences of the mining activity on the gold deposits. It should be taken into account during the restoration of terrain.

SECTION 4: ENVIRONMENT ASSESSMENT AND MONITORING

ESTIMATION OF THE CONDITIONS OF VEGETATION COVER ON THE DISTURBED LANDS IN THE REGION OF THE BOVANENKOVO GAS-CONDENSATE FIELD (YAMAL PENINSULA)

N.I. Andreyashkina
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Yekaterinburg

In the vegetation period of 1990 the territory of housing-industrial complex SU-33 and adjacent disturbed lands were studied, as well as boring sites (one of which was on the water-shed and two in the flood-lands). Before anthropogenic influence on the watersheds under study the tundra dominated (yernik-shrub-lichens-mosses, osier-grass-mosses) and osier beds (shrubs), yerniks, bogs and complex vegetation were found.

During construction and transport works on the SU-33 site primary plant community was destroyed and remained only groups of grass-plants-cereals, cotton-grass, sedge, different grasses and field horsetail; the flowing places were covered by spots of mosses (the species *Encalipta, Psilopilum, Hydrohypnum* and others).

On the rest of the territory under study due to different degree of mechanical influence on soil and plant cover in 2 to 3 years after the work stopped plant distribution was observed. Alongside the fragments of primary phytocenoses anthropogenic communities and groups of plants with mixed species composition, of one species and of only a few species were met. Transformation of the cover was considered on the example of concrete, specific phytocenoses.

The native tundra cover in the watersheds on the greater part of the territory was transformed into grassy plants. Practically everywhere were found some species of cereals (*Alopecurus alpinus, Deschampsia borealis, Poa alpigena, Calamagrostis neglecta*), sedge (*Carex stans*), cotton grass (*Eriophorum polystachion*), different grasses (*Polygonum viviparum, Rumex arcticus, Nardosmia frifida*), shoots (*Salix glauca*) and field horsetail. The surface of organo-mineral substratum was covered with a thin layer of mosses (the species *Leptobrium, Orthodicranum* and others).

On the greater part of the surface the formation of herbage may be expected in 6 to 8 years after the work influence has ceased. In the zone of the roads on the northern slope of the flat-topped hill (well 63), with the depth of the track being 0.3-1.0 m, the mosses (*Ranunculus hyperboreus, R.gmelinii*) and turf (*Deschampsia borealis*) are sparse and will take decades for natural regrowth due to a nearly complete absence of potential cenose-formators.

In the flood-land where initially bog sites (sedge-sphagnum, cotton-grass-sedge-mosses) and osiers were present the process of plant recovery was more extensive. One year after work had stopped in the area the absence of a number of grassy species was observed. In the prospective natural recovery of native plants and grasses is expected here. The overgrowing of all the parts of the territory (watershed, flood-land) was provided by local flora species.

PREDICTION OF THE INFLUENCE OF THE COAL COMPLEX ON THE VEGETATION OF YAKUTIA

E.I. Burtseva and Z.S. Pavlova
Economic Institute of Complex Use of Natural Resources, Yakutsk

In spite of the fact that Yakutia is situated on massive reserves of natural gas and oil, the role of coal in its energy consumption is quite high. The role of the coal industry is still growing in connection with the construction of the railroad and the decision to supply the regions of the Far East with coal. However, during this period of growth in industrial capacity, especially in the North, priority should be given not to the economic, but to the ecological needs, since the processes of restoration of a damaged environment are proceeding extremely slowly. The Kangal coal reserve is located 30 km from Yakutsk and the increase in coal output of up to 10 to 15 million tons a year can bring on unpredictable consequences throughout the region. The region influenced by this coal reserve has a radius of some 50 to 60 km, and can be divided into 4 zones: I - the mine itself; II - the area closest to the mine within a radius of 15 to 20 km; III - the area at a moderate distance from the mine, within a radius of 20 to 40 km; IV - the area furtherest away, at a radius greater than 40 km.

According to geochemical and soil study data intensive deposition of coal dust will give rise to an increase of basic salts and heavy metal pollution in the soils. Along with above there will be an increase in the growth of draught-resistant (*Cleistogenetea squarrosal*, Mirkin et al., 1985), ruderal (*Artemisietea jakuticae*, Gogl. et al., 1987) and hallophytic (*Thero-Suaedetea*, Vicherek, 1973) plant life. In connection with all of the above, there will be a lowing of the productivity of food plants, and under certain circumstances the food plants will be removed entirely from he overall agricultural output. The pollution of the soils by heavy metals, even in insignificant concentrations, creates extremely unfavorable conditions for plant growth.

The forests will be in the most dire straights (*Vaccinio-Piceeta* BR.-Bl, 39 em. Pass 63). A portion of the forest lands will suffer total destruction as a result of strip mining and a portion will be found to be in the zone of the strongest influences which will bring about an increase in the desiccation process with a consequent reduction in the area of forest cover by approximately 5-10 percent.

The damage, to be wrought on plant life, as a result of an increase of coal output of up to 10 million tons a year over the period of the next 40 years will total approximately 236.7 million roubles (1991): 163.4 million rbl. in zone I, 49.8 million rbl. in zone II, and 23.5 million rbl. in zone III. The overall ecological damage to the environment including the pollution of water and air, can be put at the sum of 420 million rbl. which must be compensated by the expansion of the Kangal coal complex.

METHODS OF SOIL-STRUCTURAL MAPPING OF TUNDRA LANDSCAPES ON YAMAL

V.S. Dedkov and V.P. Firsova
Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, Yekaterinburg

The peculiarity of soil cover (distinctive soil cover) of the tundra requires the development of new ways and methods of large-scale (1:10,000, 1:25,000) mapping, because the existing methods, developed for agricultural grasslands in the main agricultural regions cannot be applied in the tundra.

The tundra soil cover is extremely heterogeneous. Large (10 to 30 ha) comparatively homogeneous areas have only boggy and alluvial soils. Areas of other soils (gley, podsolic-gley and others) are represented, as a rule, by regular-cyclic nano- and microrelief (for example, spot medallion-hilly tundra) and a heterogeneity of plant cover. At present the problem of mapping the smallest geographical soil unit (elementary soil unit - ESA) has not been solved. This unit (ESA) should be relatively constant in time and space. No component of the nano-hilly-spot medallion tundra complex has such a property. Neither the soil of a spot, nor the soil of the hillocks or those of the surrounding surface may be ESA because they are in all stages in the cyclic development of tundra microrelief (new hillocks form, cracks swell, spots are overgrown and new spots appear on hills). On the other hand, micro combinations of soil, vegetation and (micro) landscapes occur or develop naturally on stable relief forms. For example, spot medallion-hummocky-tundra with small polygons always develops on crests and adjacent slanting well drained slopes on. The soil cover of these landscapes known as "scrap blanket" is comprised of regular-cyclic, small soil complexes related to the hummocks, spots and cracks. Collectively this group of each corresponds to an ESA class.

The pattern of the soil cover (PSC) often becomes complicated, for example, by soils of thermokarst bog hollows, pingos or casing mounds, distending hills, etc. that range in size from 10 to 30 m. Thus the hierarchy of the pattern of soil cover (with the increase of the value of contours) is composed of : very small-small and intermediate combinations and catenas. Nanocombinations and microcombinations are the 1st level of PSC-ESA. Elementary soil units that combine according to mesorelief form the 2nd level of PSC-these are elementary soil structures(ESS). Under ESS we recognize soil combinations according

to the relief elements (ESS of a top, ESS of a slope). The ESS combined on geomorphological features form soil catenas. For example, a catena of a watershed consists of ESS of non-soil outcrops, inter outcrop depressions, hollows, slopes and tops of watershed ridges. The linear dimensions of soil combinations are : very closely spaced, combinations and complexes (1 to 5 m); closely spaced: micromosaics, different linear arrangements, soil combinations and mosaics (50 to 300 m), large scale: catenas (500 to 5000 m).

The use of the method of soil-pattern mapping, the essence of which is successive generalization from nano to micro and meso-combinations of soils, allows a considerable increase in the information content of maps, because not only the types of soils are mapped but through the soil cover pattern the types of land forms as well.

From the primary (initial) PSC one can determine the course of events on anthropogenically disturbed lands. For example on concave (hill) tops bogging is often observe after disturbance, while on flat tops and slopes, the soils dry to such a degree that even initial bog microcomplexes vanish. Thus methodologies for biological recultivation of disturbed lands should include maps of the initial pattern of soil cover.

STATE, UTILIZATION AND PROBLEMS OF LAND PRESERVATION IN THE KOMI REPUBLIC AT PRESENT

A.A. Ermakov
State Committee on Nature, Komi Republic, Syktyvkar

The territory of the Komi Republic is 41.7 million hectares of which 28.2 million ha are at the disposal of forest enterprises; 0.6 mln ha are occupied by transport and different kinds of communications or are used for some other purposes; lands of nature preservation used or purposed for recreation occupy 0.7 mln ha. Reindeer pastures occupy 12.5 mln ha of which 8.4 mln ha are utilized.

Two hundred and seven state agricultural ventures occupy 338.5 ha; 94.1 ha is tilled, fodder grasslands occupy 180.2 ha, and pastures 64.2 ha. The total area of reclaimed lands is 50.4 ha; of which 23.3 ha have sub-surface drainage.

The quality of these lands remains unsatisfactory. At present 50% of reclaimed lands do not provide the output expected. The reduction in the agricultural lands in the republic continues. The main reason is that little attention is paid to the quality of fodder grass-lands and to increasing soil fertility. As a result smaller, remote hay-harvest and pastures have become covered by brake and low forest and some are bogged up. In the course of a study carried out in 1989 by the State Committee on Nature, Komi Republic in cooperation with the agrarian laws services, some 600 ha of non-utilized in agriculture lands were formed.

In this republic there are 18,036 ha of disturbed lands, of them 7,645 ha are worked out. By January 1, 1990 167 ha had been recultivated for agricultural use, 1,841 ha for forestry needs and 384 ha for water bodies or other purposes. The quality of recultivation of disturbed soils is not satisfactory and for the main part this work consists in mapping out the surface. Biological recultivation of disturbed lands is practically absent. An area of 98 ha contains soils polluted by industrial and other kinds of wastes, sewage, damaged agricultural and other lands. But this is only the tip of the iceberg, not taken into consideration is the effect of atmospheric pollution. One km^2 of the Pechora River basin is annually subjected to about 3 tons of pollutants contained in emissions from industrial ventures. No attention is paid to the transport of polluted clay onto high-water lands (flood plains) during flood periods.

The increase of non reforested cutover areas is common. By January 1, 1983 there were 456.6 ha of them and by January 1, 1988 this had increased to 613.8 ha. Wide application of various machines used in the process of forest cutting results in the development of "bald spots". As a rule the use of machinery, especially on overmoist soils, is followed by a complete destruction of young growth on an area of 7,000 ha. without special forest cultivation such cuttings are revegetated only by foliar species and part of these lands are transformed into areas of no vegetation. Violation of laws of forest conservancy results in the fact that about half of the concentrated cuttings in the Republic are renewed by other species.

The data provided show the magnitude of the problems concerning preservation and rational utilization of the lands in the Republic. Some measures have been already undertaken but still more are required. The successful solution of the problem, today more than ever, depends on a solid scientific and methodological rational for ecological programs and for execution of governmental decision aimed at achieving a better ecological situation in the Republic.

ESTIMATION OF THE ECOLOGICAL DANGER OF CARBON HYDRIDES

G.T. Frumin and A.B. Nazarov
Institute of Lake Investigations, Russian Academy of Sciences, St. Petersburg

Environmental pollution by oil and oil products cover large territories. In the process of extraction, processing, storage, transportation and usage, oil and oil products enter the biosphere and result in disturbances of ecological stability. In this connection there is the problem of a possible technogenic loading on different ecosystems, including the ecosystems of the North. To solve this problem it is necessary to have information concerning ecological characteristics of oil components, and especially carbon-hydrides. To estimate the ecological danger of carbon-hydrides the idea of applying their chemical exergia (activity) value is proposed, i.e. the work obtained from the matter as a result of its interaction with the environment. Calculation of chemical exergia is a very complicated

process, and that is why we suggest the following correlation equation that links the ecological characteristics of carbon-hydrides with their molecular link-capacity of the second order (^{2}x-ksyγ):

$$e = 1049 + 1754\, x^2\gamma \quad (1)$$

n = 15; r = 0.998; s = 0.125; F = 2878 (28.78?)

Evaluation of $^2x\gamma$ was made according to a specially developed program with the aid of a computer. It permitted the creation of a data bank of $^2x\gamma$ for different class combinations. Chemical exergia can be applied to the evaluation of chemical substances with respect to toxicity and factors of bioconcentration. Tables 1 and 2 show data on carbon-hydride toxicity and factors of their bioconcentration by algae.

TABLE 1
Toxicity of Carbon Hydrides for *Photobacterium phosporeum*

Carbon Hydride	$_pEC_{50}$	e, kl.Dj mmol	Carbon Hydride	$_pEC_{50}$	e, kl.Dj mmol
Benzene	0.02	3.21	4-Ethyltoluene	1.79	5.09
Toulene	0.31	3.83	Naphthalene	1.81	5.10
Styrene	1.28	4.31	4-Phenyltoluene	2.22	6.47
o-Xilol	1.06	4.46	Diphenylmethane	2.07	6.81

TABLE 2
Dependence of Carbon Hydride Bioconcentration by Algae on Chemical Exergia

Carbon Hydride	Ph B	e, kl.Dj mmol	Carbon Hydride	Ph B	e, kl.Dj mmol
Naphthalene	2.12	5.10	9-Methylphen-		
Phenanthrene	2.51	6.99	anthrene	3.66	9.31
Anthracene	2.96	7.00	Perylene	3.85	9.69
Pyrene	3.43	7.77	Benzapyrene	4.00	10.74

According to Tables 1 and 2 the following equations were obtained:

$$p^{EC}50 = -1.63 + 0.60\, e \quad (2)$$

n = 8; r = 0.92; s = 0.35; F = 31.5

$$Ph\ B = 0.382 + 0.351\ e \quad (3)$$

n = 7; r = 0.96; s = 0.23; F = 54.6

It has also been stated that chemical exergia is closely correlated with the PDK of carbon hydrides in soil.

CHOICE OF OBJECTS AND CRITERIA FOR THE ECOLOGICAL MONITORING OF OIL-CONTAMINATED BIOGEOCENOSES OF THE NORTHERN TAIGA

S.N. Gashev, M.N. Kazantseva, A.V. Soromotin and A.V. Rybin
The Tyumen Forest Experimental Station, Tyumen

The idea of using bioindicators as a monitoring system of the condition of the natural environment is not new. Bioindication is indispensable for the evaluation of the biological effect caused by one or another impact on the integrated state of the environment. This allows us to estimate the degree of danger such an impact poses for the biogeocenosis and to predict the response of living community.

Many years of research on oil-contaminated biogeocenoses of the northern taiga have shown that attention should be paid to the state of the principal structural element of the taiga forests, i.e. forest forming coniferous species. Taxonomic data in the polluted areas permit an assessment of the change in the composition and stock of coniferous trees of the plantation, as well as, the degree of the total decrease in the forest productivity. One of the indices of the effect of oil on biogeocenoses is the state of health of forest species expressed by their total abundance, correlation of species and the current growth of coniferous species by their height.

Live surface vegetation is an element of the taiga phytocenoses that is most sensible to external impact. As a basic criteria reflecting the effect of oil on the taiga phytocenoses, a change of the total standing vegetation and biomass of the above-ground part of plants can be used, as well as, variation in species and correlation of plant groups combined by similar reaction to the contaminant and common biological state of being.

For monitoring purposes, small mammals, insectivorous species (*Sorex araneus* - in the vicinity of the mid-Ob) are suggested for use higher order consumers (predators) in comparison with rodents which demonstrate more sensibility to oil contamination. More clear and convenient criteria are: total abundance of the species, morpho-physiological traits and reproduction processes in the animal population on oil contaminated territories. The use of such indices as the coefficient variation of and asymmetry are suggested for

estimation of the degree disturbance and direction of changes of animal communities in the areas of oil spills.

The equation of the allometric growth is suggested as a statement of small variations among micropopulations of the disturbed areas and the control. Small martens (*Martens sp.*) being predators of the third order and hunting species provide significant material for the statistic treatment.

According to some researchers, the soil mezofauna can also be used to monitor and measure the oil spill. The absolute number and dynamic density can be used as criteria. Correlation coefficients between the stability of these parameters (per cent in control) and the concentration of oil in the upper part of the organogenic soil horizon correspond respectively to: 0.79± 0.15 at $P<0.001$ and 0.85± 0.22 at $P<0.01$. Both indices decrease by half in the intervals of oil concentration from 8 to 12%. For the zone of the mid-Ob, *Newsteadia fleoccosa* (*Insecta, Homoptera*), *Monotarsobins curtipes* (*Chilopoda, Lithobiomorpha*) are of interest.

The possibility of using Xilothrophic basidiomicites and other saprophites as monitoring objects is suggested.

A METHOD FOR THE EVALUATION FOR ON-SITE PROTECTION OF FOREST PLANTATIONS IN THE AREA OF THE NORTHWEST HIGHWAY

R.I. Khanbekov and L.Sh. Darkhovsky
VNIIZM, Pushchino

During reconstruction, building and planning of highways for common use it is necessary to follow legislative, instructive-methodical and standardized technical documents, that regulate forest protection and sensible use of forest resources. It is important to anticipate forest preservation in thinly forested regions. Platting highways over lands covered with group 1 forests should be done in a very limited way.

Estimation of the state of the forest environment should be conducted by land users of the forest resource; groups and organizations of forest protection, land organizations and homogeneous groups of taxation allotments. Information sources for the state of the forest environment are general outlines to forestry development, forest plantation projects, forest taxation descriptions and forest cadastre books of the timber industries. Information about the forests of other forest users are contained in analogous documents of respective enterprises and agencies.

In estimating the state of the forest in the zone of highway impact, the following characteristics and indices are used: forest type, plant growth conditions, age, bonitet, cover, trunk diameter, current growth, production class, non-forest elements, health and stages of

human alteration of the forest. With these things in mind during observation of the state of the forest environment the actual presence, distribution and function of commercial objects and complexes are determined. The degree of the forest alteration under the impact of recreation; areas of and pollution of soil, the air, water and vegetation by automobiles, as well as by industrial and communal enterprises in adjacent territories and the degree of the disturbance from noise are also determined.

In order to estimate the quality of the forest environment, nature protection and health standards are applied as follows: single and average daily maximum permissible concentration of nitric oxides in the air for the forest and humans; average seasonal and maximum permissible level of ground water; maximum and average annual recreational noise level for recreation areas. Analysis of the above-mentioned data zones or areas of forest disturbance are identified as low, moderate, and severe.

When considering forestry and the economic damage for speicfic groups of land users as well as homogeneous taxation allotments measures are implemented for the preservation, recovery or transformation of the forest environment. These include preservation timber cutting, beneficial cutting, and in the natural forest, restoration, forest protection and fire-prevention, as well as, steps in forest rehabilitation-reforestation.

The cost of implementing forest protection measures is determined according to regional standards or actual expenditures of timber enterprises on the basis of 1 m^3 of timber grow to the age of maturity.

The composite estimation of the on-site protection of forest plantations is determined by the degree of disturbance of the forest and the relationship between the cost of protective measures and the cost of the economic damage that results from disturbance of the forest environment.

BACKGROUND FOR THE DEVELOPMENT OF A SYSTEM OF SPECIALLY PROTECTED TERRITORIES IN THE NATIONAL REGIONS (BASED ON THE EXAMPLE OF THE KOLA NORTH)

I.I. Kondratovich and V.V. Nikonov
Institute of the Problems of Industrial Ecology of the North, Kola Science Centre, Russian Academy of Sciences, Apatity

The most important part of complex ecological programs is the development of a scientific system of (specific) protected natural territories (PPNT), that fulfill vital functions: environmental, climate-preservation, nature-protection, scientific, aesthetic and other. The formation of the PPNT system is conditioned by a number of objective and subjective factors.

Objective factors are the physico-geographical conditions of the reginon and its social-economic peculiarities. The geological structure of the Kola North, its climate, soil and plant diversity are given in brief on maps and in the text of the "Atlas of Murmansk region". Social-economic peculiarities of the region refer to, first of all, the high level of industrial development and, as a consequence, intensive technogenic loads on ecosystems. Subjective factors refer to those which genetically bear on an organizational-lawful character. The conceptual-terminological standards used in different preserves are inaccurate and unclear and often lead to different interpretations of PPNT. The absence of a single generally accepted scheme of natural subdivision of the country into districts makes it practically impossible to create an all-union system of PPNT.

Publications and other materials on the problem, as well as our studies permits the development of a concept for the organization of a system of natural-preserves in the region. Four principles form the methodological basis of this concept: 1) the principle of systematization, 2) the principle of sufficient area (quantitative), 3) the principle of diversity of forms (qualitative), 4) the selection of categories for special protection in natural complexes. These are the structural elements of the PPNT system.

THE SCIENTIFIC BASES FOR FORMATION QUALITY RECULTIVATED LANDS IN THE FAR EAST

L.T. Krupskaya[1)] and E.V. Novikova[2)]
[1)]Mining Institute, Far East Division, Russian Academy of Sciences, Khabarovsk
[2)]All-Union Scientific Coal Research Institute, Perm

Under the conditions of the Far East the reestablishment of the productivity of lands disturbed, by mining is especially difficult due to lack of fertile soils and the considerable area of such landscapes (over 500,000 ha.). The greater part of the territory is, however, covered by agricultural and forest lands. The rate of recultivation is very small (0.1% of all of the disturbed area). The processes of extraction of natural resources does not take into account the creation dumps. The land necessary for a mining enterprise is equal to 200 to 400 ha per 1 mln m^3 of mineral mass.

Our data show the high productivity of recultivated lands. In Rettikhov (Primorshy region) and Ural (Khabarovsk region) areas the open pit coal sections were much lower than in Luchegorsky, as determined by the conditional point system. Evaluation of the quality (bonitet) of disturbed and recovered lands was carried out by an estimation of the agro-industrial indices (agricultural usefulness) of the mining area before disturbance and after recultivation.

The quality of recultivation, in our opinion, is the sum of agro-technical and ecological characteristics of a landscape created in the process of re-instituting productivity of the disturbed lands and determining fitness for, and perceived use of this territory, in the

agricultural branches of the economy. The qualitative recovery of the landscape depends on the proper and timely recultivation, the task of which is to create optimal conditions for the formation of physico-chemical, hydrological, hydrogeological and agro-chemical properties of the soil.

The following points are suggested as a scientific basis for the formation of a formula for the quality of recultivated lands:

1) Monitoring of all the factors of ecogenesis including soil-formation (supported by legal, ecological, technological and biological standards).

2) Accelerated formation of a porous organo-mineral soil complex by the use of humic ammendments (peat, biotechnology), highly productive plant communities, microorganisms and animals.

3) Selective dump-formation that will permit the formation of soil with "genetic" horizons of different textural and mineralogical composition and that will provide the necessary available moisture for plants.

In order to monitor the quality of recultivation a matrix was compiled based upon agro-industrial indices: surface relief, acidity, litter composition, fraction <0.01 mm, humus content in %, and the presence of phytotoxic minerals.

In technical design conditions we consider it necessary to provide indices that characterize how well the individual recultivation processes perform as well as the individuals who perform the operations.

The evaluation and monitoring of the quality of recultivation promotes not only an increase in productivity of reestablished lands but also a decrease of negative impacts mining has on ecosystems. They also promote the creation of conditions for successful self-reestablishment of destroyed natural relations, a reduction in costs of the extracted minerals and the increase in efficient use of investments in land-recovery projects.

MICROBIOLOGICAL MONITORING OF MICROBE COMMUNITIES FORMED ALONG WITH PHYTOPATHOGENS MICRO-ZONES IN THE SOIL

T.M. Lagutina
Pushkin Institute of Microbiology, St. Petersburg

A procedure has been developed that permits modelling and study of the process of formation, in the soil, of microbe communities with phytopathogenic fungi. The procedure is based on he use of membrane filters and methods of soil microbiology.

In this procedure spores of the phytopathogen under study are placed on the membrane filter. The filter with the test fungus is placed between layers of synthetic fabric, the soil micro-organisms can freely penetrate to the membrane filter and colonize the test fungus.

The study of this process allows us to hypothesize about the inter-relationship of the pathogens understudy and the soil micro-flora. It is advisable to observe the formation of the colony as it takes place near the phytopathogen. After the incubation period is over, the filters are removed, a certain portion is cut off and put into a bottle of sterile water, stirred, and vibrated for 30 min., prepared in a 10 strength solution and inoculated. The bacteria are isolated on a beef-extract agar, the fungi on Chapeks medium, and the actinomycetins in Gauzes medium. A count of the number of microorganisms on a given medium permits the determination of the degree of compactness within the colony and thus describes a quantitative method for the colonization of the soil microzone with a test fungus of soil micro-flora.

The growing colonies can be characterized not only quantitatively but also qualitatively by isolating the various micro-organisms found there, into pure cultures. In this way the composition and the bio-chemical characteristics (the production of fermentations, toxins and anti-bodies) of the species can be studied and a determination can be made of its inhibitory or neutralizing effect on phytopathogens.

To insure uniformity of the process of separation of micro-organisms, the developed colonies are visually divided into morphological cultural types. The amount of each type is calculated and a pure culture is isolated from one sample.

Study of the inhibitory characteristics of the sample taken from the microbe colonies formed near the phytopathogens provides data about the micro-biological factors responsible for the suppressivity of the soils.

Using a special device to provide nourishment, it is possible to follow the development of the different physiological groups of micro-organisms comprising the colonies. By comparing the complexes of micro-organisms extracted from the colony formed in the microzones with the test fungi and the soil particles, it is possible to determine the trends of the microbiological processes, taking place in the soil near the phytopathogens.

The proposed method for monitoring the microbe colonies is universal. For a test organism, one can introduce any micro-organism. Using the latest research methods in the field of soil microbiology, it is possible to continue to broaden the field of research by using simulated conditions to closely approximate those of the actual soil.

COMPUTERIZED METHODS FOR ANALYZING THE OIL-POLLUTED AND DISTURBED SOILS OF THE CENTRAL TAIGA FOR THE PURPOSE OF DEVELOPING MEANS FOR THEIR RECULTIVATION

A.A. Lapenkov and O.M. Tereschenkov
State University, St. Petersburg

The main problem in the task of deciphering the aerial and satellite photographs of the oil field regions is one of identifying systems of land management which consist of two interrelated parts (subsystems): the natural and technogenic. By means of aerial and satellite photos, the properties of both the first and the second subsystems can be analyzed. The results of this two-part analyses mutually enhance one another and offer materials for the evaluation of the anthropogenic burdens on the ecosystems and their related stability.

The analysis of satellite photos of areas of intensive anthropogenic utilization, such as villages or cities, industrial areas, oil and gas fields, roads, etc. is easy. However, because of their small size, the polluted territories, shown on satellite photos of medium and small scale, cannot be analyzed by visual-instrumental methods. The use of computerized methods for analyzing the aerial and satellite photographs affords us a more objective evaluation of the degree of disturbance of the various types of ecosystems and a relative comparison with non-polluted areas for a whole range of conditions.

For the computerized analysis of aerial and satellite photographs we used a complex system of video analysis, BVS-6472, from the firm "Robotron", which offers a system of devices for the encoding and interaction with video data.

Thanks to the modular principle of the equipment it is possible to form an optimal configuration, corresponding to the various tasks of encoding the data. The peripheral equipment, complex and specialized, (excluding the color monitor) is connected with the IBM computer through controllers. The IBM works as a director for the operating devices and carries out the analysis of the data. The synchronization of the special devices is carried out by a central operating system.

Along with the fragmental analysis (scanning) of the information field of a photo, with the accent of decoding with the help of 5 to 7 types of computer drawings, it is possible to produce control fragments of drawings in the form of histograms with a distribution of colors, representing density. The narrower the range of color distribution, the more uniform the control area. Thus, comparing the histogram of the disturbed soil-vegetation cover, resulting from oil-pollution, with the analogous non-polluted areas which are distinguished by the character of their color distribution, it is possible to evaluate more reliably and with more objective methods the degree of change (disturbance, restoration or pollution) of the ecosystem in the region of the oil fields.

AN AREAL-MAPPING APPROACH TO TERRITORIAL EXPLOITATION AND RECULTIVATION

N.A. Loshakova
Institute of Photosynthesis, Pushchino, Russia

In choosing an area for development or recultivation, there always arises the problem of evaluating it from the point of view of the intensiveness and character of the natural processes. It is a necessary condition for the wise and ecologically sound use of natural resources, that the proper choice of technique be used, which reflects the corresponding methodology.

In the laboratory of soil mapping of the Institute a method of molded (plastic) relief has been worked out and used in the practice of thematical mapping. In this method a line is drawn through the points of zero curvature of "horizons". Geometrically and through the second derivative it reflects a planned (horizontal) curvature of the earth's surface, that by a mathematical convention is transferred from a continuous picture into individual frames. The method is named "morphoizographa".

The method of molding permits the construction of relief maps of any territory and at any scale. These maps permit one to observe the earth's surface on any hierarchy level. This morphological image can be analyzed mathematically, because any section has an exact geometrical form that adequately reflects a natural formation within actual physical processes. Thus, the reflection of the structure of the earth surface is more objective and closer to the natural structure.

We regard the basin as an elementary or primary unit in which natural processes go according to the certain laws and rules exactly within the boundaries of the basin, these areas are distinguished by the molded relief, for any level and scale. At the same time, the interaction between two basins, their mutual influence, the role of each basin in the system (subordinate, autonomous), and the correlation of the parts of the system, are clearly seen.

In the process of the recultivation and/or exploitation of regions it is necessary to have a good idea about the position of the chosen site in one or another system (basin). Three main zones are distinguished that are connected with each other by the gradient of height (curvature of the surface): 1) the zone of the formation (outcrop zone) always acts independently, 2) the zone of accumulation is always subordinate, and 3) the zone of transit is the place of both the deposition of the material from the zone of formation and the additional source for the zone of accumulation. With molded relief maps it is easy to define the degree of conformity of the chosen site and its parts to the zone, as well as the degree of interaction among the zones of different levels. The local and long-distance transformation of the territory under investigation depends on this.

BOTANICAL MONITORING IN THE IMPACT ZONES OF GAS-PRODUCING OBJECTS IN THE NORTH OF WEST SIBERIA

M.A. Magomedova
Institute of Plant and Animal Ecology, Yekaterinburg

Botanical monitoring records the state and dynamics of vegetation. As one of the components of ecological monitoring, botanical monitoring is done on three levels: global, regional and local. It is an effective system for early warming because there are joint observations on all three levels. Our aim was to develop a concept of botanical monitoring that could be applied to the complex conditions of extraction, preparation and transportation of gas produced in the sub-arctic tundra of the Yamal peninsula, including the expected and actual impacts on vegetation.

Global parameters influencing landscape development on Yamal are climatic fluctuations and background atmospheric contamination however, they are not considered in the suggested concept. On the regional level the role of climatic fluctuations in the dynamics of erosional processes, the change of vegetation from the impact of reindeer, the scale of mechanical destruction of plants, as well as the level of contamination from various sources and character should be taken into account. On the local level destruction and transformation of plant communities and their components that result from mechanical impacts, pasture and contamination have been studied.

It is evident that monitoring of all levels should be combined into a single system. Besides vertical ties it is important also to correctly organize horizontal ties by controlled parameters on all levels. Interpenetration of the monitoring levels relies on the combination of distant zoning within the network of terrain stations. The continuity of this system and its success is assured, by an optimal quantity of basic stations and controlled parameters in them.

The choice of sites is governed by their representativeness, ecological or economic importance, sensitivity to controlled impacts and the possibility to establish permanent stations. Where it is possible organization of permanent control sites beyond the action zone of impact of a particular factor is planned.

Vegetation has undergone and will continue to undergo stresses on four levels differing in time and character: intensive reindeer grazing; exploration, well drilling and prospecting; construction of industrial complexes for the extraction, preparation and transportation of gas; exploitation of the complex. Every level has its own character and scale of impact, and their careful evaluation is necessary. The first two levels and to some extent the third one have been analyzed in the region of Bovanenkovo station and monitoring is currently being done there. The third and fourth levels are monitored at the Yamburg industrial complex. Predictive evaluation and the development of a monitoring network is planned for the Bovanenkovo station.

RESPONSE, RESISTANCE TO AND RECOVERY FROM DISTURBANCE IN ARCTIC ECOSYSTEMS

Helen M. McCammon
Department of Energy, Ecological Research Division, Office of Energy Research, Washington, D.C. 20585, USA

In 1985 the U.S. Department of Energy initiated a study of the Response, Resistance and Recovery from Disturbance of arctic ecosystems (R4D Program). This study was directed toward the determination of natural long-term dynamics of the physiological hydrological and geochemical processes within a representative upland tundra ecosystem in arctic Alaska. And To incorporate these data within a hierarchy of predictive disturbance-response models with both local and regional application. This program extends the heritage of the Department of Energy's (and its predecessor organizations) support of arctic ecosystem research which began more than 30 years ago.

Studies within the R4D program have monitored drainage basin-level ecosystems over a period of six years and have established with a high level of certainty both the mean and the amplitude of variability for the driving variables; hydrology and geochemistry in the natural (or undisturbed) watershed of Imnavait Creek. Concomitant structural and functional ecosystem-level studies of vegetation have resulted in the production of a group of models that permit the prediction of the response of ecosystem components (vegetation, surface and active layer hydrology/geochemistry) to various levels of disturbance related to energy exploration and development in the Alaskan arctic.

Coupled with existing site and regional GIS systems these models are being tested for their accuracy in predicting both local and regional response to disturbance such as dust generation, surface drainage impoundment and nutrient release. Hydrologic models developed in the course of this program offer the prospect of simulating both hydrologic and geochemical responses on a regional or local scale in similar tundras to changes in temperature and precipitation predicted by various Global Change models.

The synthesis of this research can provide the energy extraction industry with a range of development strategies that minimize ecosystem disturbance and assist in development of disturbance contingency/mitigation plans.

ON THE WORK OF THE INSTITUTE OF SCIENTIFIC AND APPLIED RESEARCH "AERO" ON THE SOLUTION OF PROBLEMS OF ENGINEERING ECOLOGY FOR THE URALS AND NORTHERN REGIONS

V.A. Nikulin
Institute of Scientific and Applied Research "AERO", Izhevsk

The Institute of Scientific and Applied Research "AERO" (which means Aerial-Hydrodynamics, Ecology, Resource Economy and Education) was established by the Executive Committee of Izhevsk. The founders of the AERO Institute became the State Committee on nature protection of the Udmurtia Autonomous Republic. The primary objectives of the "AERO" Institute are to conduct scientific-research and predictive studies, exploration and experimental studies, expert studies in the fields of engineering ecology and resource economics, studies of the physical problems of new technologies and conversion, studies on more complete and effective utilization of industrial wastes and the utilization of local raw-materials and labor resources, license and provide information.

The solution of problems of economic and social development of the Urals and of northern regions demands a radical improvement of the ecological situation, rational utilization of natural resources, strengthening of the protection of air and water basins, reduction of land losses (erosion) etc. One of the concerns in the development of present-day construction is the influence that these activities have on the microclimate of the towns, villages and other populated places, for example, changes in the wind regime and humidity of the air. The development of industry, energetics and transport leads to an increase in pollution of the environment. Studies on protection from strong winds, dust,and snow retention and utilization, etc. are necessary. All these problems can be solved by means of engineering ecology methods.

Data are given in the studies on ecology and resources economy for the Urals and the North concerning for example the processing of industrial wastes, utilization of ash from heating stations and metallurgical slags, the purification of water and saropels (slimes) from salts of heavy metals and the automation of observations on ecological situation in a single town or the North as a whole.

ANALYSIS OF THE STABILITY OF THE HUMUS-VEGETATION SYSTEM BY THE METHOD OF MATHEMATICAL MODELING

I.M. Ryzhova
Moscow State University, Moscow

According to the present understanding the system of humus-vegetation is a complex self-regulating system with reverse connections. Regulatory functions of such systems are conditioned by their essential non-linearity. It is of interest on the basis of a non-linearity

model of humus accumulation to find out the possible stationary conditions of the system, to define the conditions of the system transition from one state into another and to find effective parameters of the system transition into a new state.

Consider the non-linear model of humus accumulation in authomorphic soils of the zonal natural ecosystems:

$$\frac{dx_1}{dt} = k_{21}x_2 - k_1x_1 \qquad \frac{dx_2}{dt} = k_0p_0\frac{x_1}{d+x_1} - k_3x_2 \tag{4}$$

where x is the stock of the humus carbon in the soil, x_2 is the stock for carbon in the dead phytomass; p_0 is the potential productivity of phytocenosis (parameter reflecting potential possibilities of the site for the creation of organic substances by higher plants); k_0 is the part of production evolving annually into the decomposition cycle; k_{21} is the coefficient of humification of plant remnants; k_1 is the coefficient of humus mineralization; and k_3 is the coefficient of the decay of dead phytomass. In this model the interaction of the biota and humus is reflected. It also takes into account the fact that not only the quantity of plant remnant affects the level of humus accumulation but vice versa, the productivity of phytocenosis depends on humus content. To show this dependence a hyperbolic function was used analytically and it permitted a better description of the close interconnection between productivity and the contents of humus at early stages of soil formation and its weakening as the system approached the stationary state.

Excluding the variable x_2 system (1) may be brought to one equation of the second order relative to x_1:

$$\frac{d^2x_1}{dt^2} - \frac{k_0p_0k_{21}x_1}{d+x_1} - (k_1+k_3)\frac{dx_1}{dt} - k_1k_3x_1 \tag{5}$$

The form of this equation coincides with well-known equation of motion for a material particle of an isolated mass, moving with dissipation described by the second member in the right part (2), in the outer field, the potential of which looks like:

$$U(x_1) - \frac{-k_1k_3}{2} \qquad x^{2_1} - k_{21}k_0p_0[x_1 - a\ln(d+x_1)] \tag{6}$$

The stable point of equilibrium is the point of the local minimum potential. The positions of the local potential minima at various values of the effective parameter are:

$$Q = \frac{k_0 p_0 k_{21}}{d} - k_1 k_3 \qquad (7)$$

It is clear that for $q<0$ the potential minimum corresponds to $x_1=0$, however, with the increase of q its depth decreases; at $q=0$ instability appears and after that at $q>0$ minimum appears with $x_1>0$:

$$x_1 = \frac{k_0 p_0 k_{21}}{k_1 k_3} - d \qquad (8)$$

From the above analysis it follows that at $q<0$ humus accumulation in the system does not occur, at $q+0$ it is in an unstable condition, at $q>0$ humus accumulation starts in the system, thereby the magnitude of the stationary humus stock with the rise of q will increase. It is generally known that humus accumulation in the soil is defined by the joint action of plant remnants, their humification and humus mineralization. The analysis on the basis of this model allowed us to find the functional interaction between them, since an effective parameter of the system q which defines the humus accumulation in the soil is a function of parameters characterizing the above mentioned processes.

The suggested model may be useful for the analysis of the soil formation possibilities depending on natural conditions during terrain restoration.

THE INFLUENCE OF THE DEVELOPMENT OF CITY LANDSCAPES ON THE EFFECTS OF WINDS IN POPULATION CENTERS

J.E. Sinitsyna
Institute of Applied Research "AERO", Izhevsk

An investigation was made on the inter-action of wind with buildings, other structures and greenery of various forms. On the basis of models of regular surface turbulence, newly-derived systems and relationships that describe wind flow around buildings, structures, greenery, topographic features have been developed. Within the surface air mass, these features can be viewed as various forms of surface irregularity. The various forms of irregularity have been classified and their influence on the character of the air mass at ground level studied.

The regulation of building density, the revision of site orientation as regards a building's height and the use of the topography all can have a positive influence on the micro-climate. We recommend that measures be taken to control the surface air mass through the use of greenery and surface features. Laboratory and full-scale studies have permitted the development of practical recommendations which are being used in planning living microcosims.

REGIONAL ECONOMIC ASPECTS OF SOIL RECLAMATION

I.V. Spiryagin
Institute of Economic and Social Problems of the North, Komi Research Centre, Syktyvkar

The major problem of nature preservation strategy for a region is the definition of the scale of reclamation and the resources spent for such aims.

According to data of the Komi Republican Statistic Agency, by the beginning of 1990 there were 18,000 ha of disturbed lands (or 0.042% of the total land area), and out of them 12,400 ha (69%) had been disturbed during geological prospecting and the development of deposits. In 1990, 2,100 ha of disturbed lands were designated for reclamation, and 2.7 mln roubles (3% from the annual expenditures for nature protection in the Republic or 18% of expenditures for land protection from pollution and for reclamation) were given for this purpose. The amount of the disturbed lands in the Arkangelsk region is 0.02% of its area, and for reclamation about 0.9 mln roubles were spent (1.3% and 23% of the above mentioned expenditures respectively).

In the Russia and RSFSR by January 1, 1989 the total area of the disturbed lands corresponded to 0.085% and 0.06% of the territory. Russia spent 0.17 billion roubles for reclamation (31% from expenditures on land protection or 1.5% of annual expenditures for nature protection). It is essential for these expenditures to be stable in time for at least five years. The insufficiency of such resources should be noted for a complex land recovery including both technical and biological reclamation.

Considering the prospects for the economic development of the region, attention should be given to the protection of the amount of land in productive industry, when constructing pipe-line systems. The mechanisms of material stimulation of industrial organizations in cases of protection of surfacial ecosystems, recultivation of the disturbed areas are of special importance during the transition to new methods or forms of local economy. Changes in the legislative acts on land and forest and strengthening of economic responsibility for disturbances requires the development of a management system by the regional land fund.

SURVEY OF DISTURBED TUNDRA ECOSYSTEMS IN RAILWAY CONSTRUCTION ON YAMAL

Yu.S. Tolchelnikov, Ya.S. Kraft, O.V. Rebristaya, A.M. Grebennikov, E.A. Kondrashkin and M.V. Priklonsky
Sovintervod, Moscow

The discovery of large gas-condensate fields on Yamal caused intensive preparations for their industrial development and the extension of prospecting for new fields. This has led to an increase in disturbances of tundra ecosystems . To prevent further damage to the natural state of Yamal by man, some definite sanctions should be used against organizations-disturbers. There sanctions should be based on a survey of anthropogenic disturbances. With the aim of obtaining exact information on the conditions of the natural tundra, a method of mapping of different types of ecosystem disturbances with the use of aerial photographs is being developed.

Natural and disturbed tundra ecosystems of the Yamal along the Ob-Bovanenkovo railway were studied in detail. The degree of the change was identified for vegetation communities and soils at disturbances of different types and intensity. On this basis a classification of different tundra types, ecosystems, and their anthropogenic disturbances were developed and their appearances on the aerial photographs were recognized. Special lists were developed for the characteristics and registration of disturbances. The ecosystems characteristics, the types of their disturbances and response of natural complexes on these disturbances are recorded.

In the course of this work it was shown that railway construction in which nature-protective technology was used had less negative influence on tundra ecosystems than geological explorations, the construction of gas-pipelines and other industrial constructions. The aerial-photographs document all the disturbances on the tundra in detail.

THE PROBLEM OF THE RECONSTRUCTION OF WATER BODIES POLLUTED BY XENOBIOTICS

N.A. Tolokontsev and S.E. Slotina
Institute of Lake Investigations, Russian Academy of Sciences, St. Petersburg

The increases of geological research work, the growth of oil and gas producing industries, towns and settlements in the North of the country, the application of fertilizers and chemicals for plant stimulation together with atmospheric interferences from western regions combined with components of drilling solutions, oil products, sulfuric compounds, agricultural chemicals, and other wastes result in pollution of water bodies in northern territories. Northern soils link many water bodies, especially during the spring and summer

floods, joining lakes into one system. Thus, problems related to the preservation and reconstruction of this joined system, instead of being local, appear to be regional.

Pollution of surface waters by toxic compounds, many of which are true xenobiotics, makes the problem of the utilization of nature and its degradation still more acute because of conflict between ever growing social demands and water, soil, flora, and fauna. Chemical pollution of water bodies presents a double danger. First is the direct connection with people who use this water and second, the indirect connection with the destruction of water ecosystems and the decline of the water's capability for self purification, which results in a decline in its quality.

While working on programs and plans directed toward the reconstruction of disturbed water bodies, the problems of water quality must be considered first of all. It is evident that of the 14 ways water may be utilized, the most important are those of human utilization and fish culture. It should be mentioned that the present water (quality) standards are not sufficient. They must be supplemented by standards for local health conditions, for example, data concerning toxic substances within a given water body. That is why, taking into consideration water quality it is sometimes desirable to consider not chemical criteria and indexes alone, but biological parameters that determine its ability for self purification. The links between chemical-biological indexes are for the most part direct, but sometimes, they can be inverted. For example, some ecosystems may be "good" (Shvartz, 1976), but the quality of water, low.

Special attention should be given to the fact that by estimating water quality according to biological criteria, the conclusions about its high quality may be false, for example if the water is polluted by the compounds containing phenol structures, this water body can appear to have low biological productivity (oligotrophic). Such compounds stop the formation of primary production which is "the point of the development of hydrobiology" (Vinberg, 1961).

In conclusion it is necessary to say that the complexity of the problem concerning the quality of water and ecosystems of the reconstructed areas is conditioned by the fact that "... ecological systems in the industrial and urbanized society cannot be preserved in their primary, natural condition..." (Shvartz, 1976).

HYDROCHEMICAL PARAMETERS AS AN INDEX OF THE DEVELOPMENT OF THE NORTH

V.P. Uchvatov and V.N. Bashkin
Institute of Soil and Photosynthesis of the Russian Academy of Sciences, Pushchino

Hydrochemical indices (the chemical composition and modules of elements that flow from the territories) are the primary parameters that define the condition of the environment. In the development of any region including the northern ones, anthropogenic modification transforms the natural hydrochemical values. In the past, and especially in the present-day, such changes for the North are connected with large scale forest cutting, timber floatation, drainage, landscape improvement, melioration, and recultivation that result in changes in water flow accompanied by changes in its chemical composition and the indices of elemental output. Meliorative measures that result in a decrease in the level of the first water-bearing horizon (water table), lead to the impoverishment of the upper soil layer (0 to 20 cm), from which soluble forms of macro- and microelements are removed with drainage waters into rivers, thereby changing their chemical composition.

The decrease in concentrations of soluble forms of plant nutrient elements ranges between 20 and 30% from natural conditions: this in turn leads to a decrease of bioproductivity of grass ecosystems by approximately the same percentage and eventually to their degradation. Cases of the death and the fall of timber stands as a result of the decrease in ground water level which removes the source of nutrition from the root system are well known. This may result in an increase of fodder biomass from which the entire region benefits, but the ecological and geochemical situation in the region becomes worse, e.g. the decreased functioning of the soil cover, through the loss of soluble elements which change the chemical composition of ground and river waters. As a result, the change of hydrochemical conditions in rivers, lakes and reservoirs leads to a change in ecological and geochemical conditions of the hydrobionts. This fact accounts for the decrease, at present, in the number and composition of species. This is true even if we exclude the influence of strong technogenic factors and the level of fish catch, which is steadily decreasing.

Another important factor that determines the change in chemical composition of surface waters is the influence of sewage waters and those from industrial enterprises that lack modern technological facilities for the purification of sewage. The investigations show that even under steady water flow, the flow of elements that pollute the environment, increases in proportion to the increase in concentrations from industrial-urban areas. Thus the natural indices of the majority of elements studied that flow into the White and Barents seas at the mouths of rivers are characterized by the following averages for the North European territory are: Cu 0.7 to 1.5; Ni 0.2 to 0.6; Zn 2 to 5; Mn 2 to 6; Al 5 to 60 kg km^2 per year respectively, maximal values of ion flow, as a rule, are in the basin of Lake Onega.
together with the above mentioned, there exist many other problems in the North, the solution of which should be an inseparable part of the ecological program of rational exploitation of nature in the region.

THE PRESENT STATE OF THE ATMOSPHERE AND CLIMATIC ASPECTS OF THE DEVELOPMENT OF THE NORTH

Z.I. Voyevodova
Institute of Economic and Social Problems of the North, Syktyvkar

The northern territories are characterized by very unfavorable external climatic and living conditions. The development and production of the regions wealth without disturbance to the environmental balance is practically impossible.

The northern territories cover over half of the territory of Russia and in them is produced about 70% of the nations oil and gas, about half the timber, as well as raw materials for non-ferrous metallurgy and phosphorus nutrients (phospate fertilizers). The area produces 6% of the gross national output and the number of people in the production of these materials is 3.5% of the country.

The northern territories are developing intensively. Interrelated complexes oriented mainly to production of raw materials have been formed. They negatively effect the ecosystems and cause controversies between the active use of the natural wealth and nature preservation.

Mining production pollutes the air and eventually the entire environment, destroying the nature of that region. At present there are over 100,000 sources of air pollution, and only 33,530 or 31% have purification devices. There are about 11.5 x 10^6 tons of pollutants thrown into air, 30% of them are solid. Gaseous contaminants include: sulfur dioxide 3.7 x 10^6 tons; water 2.2 x 10^6 tons; nitric oxides 5.8 x 10^5 tons and hydrocarbons 3.2 x 10^6 tons. The gases comprise 25 to 30%, and hydrocarbons 48%. Other specific substances and heavy metals, which accumulate in the tundra and taiga biocenoses and result in their degradation, also pollute the environment.

Air pollutents in industrial centers contain specific and toxic pollutants: sulfuric components, carbon monoxide, hydrocarbons, merkaptane, etc. exceed the limits of the allowed concentration by 10 times in some cases. They are very dynamic and cover great distances from their sources. They result in acidification of precipitation and spoil rivers (air pollutants are more dangerous to rivers than sewage waters). They destroy reindeer pastures (moss and iceland moss [lichens] are very sensitive to pollution since their nutrient uptake is from the atmosphere), they also effect forests and environment. The degree to which the pollutant admixtures breakdown depends directly on solar energy (radiation balance and temperature regime) as well as moisture.

Criteria for the self-purification of the environment in the European northeast are developed on the basis of climatic data and an evaluation of the degree of self-purification that has been made. Three groups of climatic indices effecting pollution and natural recovery were considered: a) factors promoting environmental contamination in winter; b) factors promoting redistribution of contaminants during the warm period; c) factors that

promote the natural recovery (temperature over 10°C; sunshine; thunderstorms etc.) There are regions with normal, low, and very low degrees of self-purification. The European northeast has a low or very low potential for self-purification.

Accumulation of contaminants in the North is more intensive than in mid-Russia, due to low energetic climatic factors. With every year of development in this region the process of contamination becomes more acute with new contaminants added to old undecayed pollutants in soil, vegetation and river beds. It is necessary to define the permissable concentrations of pollutants.

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS TO THE PROBLEM OF CUMULATIVE IMPACTS IN THE PRUDHOE BAY OIL FIELD, ALASKA

D.A. Walker[1], M.D. Walker[1], L.R. Lestak[1], K.R. Everett[2], P.J. Webber[3]
[1]Joint Facility for Regional Ecosystem Analysis(JFREA), Institute of Arctic and Alpine Research(INSTARR), University of Colorado, Boulder, CO 80309
[2]Byrd Polar Research Center, The Ohio State University, Columbus, OH 43210
[3]W.K. Kellogg Biological Station, Michigan State University, Hickory Corners, MI 49060, USA

Much of the future energy resources of the world will come from existing and new oil fields in arctic regions. The Prudhoe Bay Oil Field (PBOF) in northern Alaska was the first major arctic oil field in large-scale development in other parts of the Arctic. Cumulative impacts are defined in regulations published by the Council on Environmental Quality (CEQ) as:

> ...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Although environmental legislation in the USA requires evaluation of cumulative impacts (CEQ 1978), very few environmental impact statements treat the problem adequately because standard methods and a comprehensive approach to address cumulative impacts are largely lacking. Existing methods fail to consider indirect effects which may occur years after the direct disturbance. The first step towards predicting future events of development must be based on historical models. Other published studies have emphasized the importance of examining large landscapes and of using long-term historical case studies (Horak et al. 1983, Beanlands et al. 1987, Bedford and Preston 1988).

This analysis utilizes geographic information systems to trace the history of development from 1968 to 1983. We mapped three 22 km^2 areas of intensive development at 1:6000 scale, and the entire field (500 km^2) at 1:24,000 scale. Recent advances in computerized cartography and geographic information systems (GISs) lend themselves well to such

"historical" studies of terrain change. Maps of natural geobotanical characteristics (including vegetation, soil landforms, surface forms, and percentage open water; anthropogenic disturbance into a single master map termed an 'integrated geobotanical and historical disturbance map' (IGHDM). Using the ARC/INFO GIS software, a great variety of maps can be produced, including: (a) maps of single geobotanical characteristics, (b) derived maps based on combinations of geobotanical characteristics (e.g., landscape sensitivity maps), (c) maps depicting historical natural and anthropogenic changes, and (d) maps utilizing complex models based on experimental and observational data. Methods of making integrated maps are described in Dangermond and Harndon (1990). Complete methods of making the IGHDM are described in Walker et al., (1986, 1987).

Analyses of the maps show several important trends: (1) Within the entire field, 350 km of roads were constructed; 21 km^2 of tundra were covered by gravel; another 14 km^2 were flooded because of road and gravel-pad construction. (2) The pace of development was nearly constant throughout the 15 years of the study. (3) Within the three areas of intensive development, an average of 29% of the areas had some form of disturbance by 1983. (4) Within an individual map area, road construction tended to level off after about five years, but construction of new and expanded gravel pads continued in a linear fashion throughout the period of study. (5) On the 'flat thaw-lake plains' landscape unit, indirect impacts (those that are unplanned for, such as flooding, thermokarst, dust effects, construction debris, and off-road vehicle trails) exceeded the direct impacts (roads, gravel pads, and gravel mines) (840 ha vs. 560 ha). In the wettest portions of the oil field, indirect impacts (mainly flooding) were more than double those of direct impacts (522 ha vs. 223 ha).

In the 'floodplains and terraces' landscape unit, direct impacts (mostly gravel mines) were dominant. (6) In the flat thaw-lake plains, dry and moist sites were disproportionately selected as construction sites. This has important implications for wildlife species, particularly waterfowl and shorebirds, that utilize these areas as nesting sites in wetland complexes. (7) Anthropogenic impacts within the study areas ere two orders of magnitude greater than natural disturbances within the same area from 1949 to 1983 (746 ha vs 8 ha per 66 km^2). Flooding and thermokarst are important aspects of cumulative impacts in arctic wetlands. For roads on elevated berms. Thermokarst appears to be a synergetic impact. Prior to 1977 there were low levels of thermokarst, but it increased thereafter, probably due to many interacting causes such as road dust, the slow death of vegetation near the rods, and flooding of roadside environments.

Proposed development in the Arctic National Wildlife Refuge (ANWR) in northeast Alaska raises serious concerns regarding the prospect of several very large oilfields in this pristine region. The oil industry has stated that the PBOF is not a good example of the type of development that could be expected in ANWR because of new technology developed during and since exploration of the PBOF and the different type of terrain likely to be encountered in ANWR (rolling foothills in ANWR vs. flat thaw-lake plains in the PBOF) (Robertson 19898). A newer field, called the Kuparuk Oil Field (KOF), in the rolling terrain west of

Prudhoe Bay may be a better analogue, and identical methods should be used to compare the two networks are similar and the combined effects of the two fields essentially doubled the rate of development on the North Slope after 1978 when development began in the KOF. IGHDM techniques could be employed in the Soviet arctic if accurate base maps, preferably at a scale of 1:6000, and a series of aerial photographs showing the history of development are available.

GEOBOTANICAL CHRONITORING AND RECLAMATION PROBLEMS OF THE NORTH

O.Y. Yuzytch
Lvov State University

At present it is necessary to have ecological mapping as a basis for nature preservation measures. Maps must be both large scale to make it possible to single out separate biots and sufficiently small scale to document the ecology and plan nature preservation on vast areas.

In this respect geobotany (applied geobotany to be exact) is of considerable interest. It differs from other biological sciences because, for all practical purposes, it includes all ecotops that are already understood, i.e., agrocenoses, natural range lands, regions of solonchacks (saline soils), forest reserves and improved lands. Researches of *giprozems* study only agrocenoses, scientists of forest institutes are engaged in the study of forest reserves, scientists of ecological preserves and national parks study standard areas that are usually not large in size.

Geobotanical mapping is done according to a regional administrative standard which makes it easier to collaborate with local authorities and to have base maps from Agroprom and VISHAGI. The scale of mapping depends on the natural zone and the need of detailing biotopes (community habitat). It may range from 1:10,000 to 1:500,000. For instance, at the scale of 1:10,000 it is possible to single out areas of 0.1 ha., i.e., very small biots (for example, separate big trees). Scales of 1:500,000 can be used for a long term planning of nature preservation measures.

The idea of "geobotanical chronitoring" means that periodic inspections (once in every 10 to 15 years) can play a considerable role in nature preservation. Thus, comparing the results of the last two inspections it is possible to learn if there is any damage done to the environment by the activities of people. During the inspection it is easy to see symptoms (indications) of disturbances to the ecology. These symptoms are: an intensive growth of some types of plants (or a group of species) that may have been brought from other regions, the appearance of paths, pits, hillocks and other features caused by anthropomorphic pressure.

The vegetative cover in the North is extensive, easily disturbed and takes much time to recover. Thus, systematic observation of that biosphere and its vegetative cover is possible only on very limited areas such as preserves by a certain number of specialists in the field. This does not guarantee the requirements for nature preservation. Therefore geobotanical chronitoring or periodical mapping of vegetation changes of the area at a large scale can serve as a basis for planning and carrying out nature preservation measures.

ESTIMATION OF THE TRANSFORMATION OF THE WEST-SIBERIAN TUNDRA LANDSCAPES IN RELATION TO DISTURBANCE OF THEIR VERTICAL STRUCTURE IN THE COURSE OF DEVELOPMENT

V.A. Zaitsev
Moscow State University, Moscow

The sharp increase in anthropogenic influence on the nature of the North causes the transformation of tundra geosystems, disturbance of their structure and regimes of functioning, that lead not only to a worsening of the quality of the environment and loss of biospheric resources but, also to the complete destruction of local geosystems, the deterioration of lands, and the formation of lifeless wastelands and technogenic badlands over considerable areas. Because of the recent start of their economic development, the main problems of stability and changeability of these geosystems, i.e. the stabilization of their structure and function, the character of the anthropogenic transformation and self-recovery together with the character and conditions of the development of landscape degradation processes, remain unclear and debatable. We think it is possible to solve these problems on the basis of analysis of changes in the vertical structure of landscapes as a result of development.

It should be noted that until now there was no satisfactory classification of technogenic influence and related schemes of classifying the nature of disturbances suitable for analysis, or estimating and predicting the conditions of transformed geosystems. It is suggested that all technogenic influences, local, linear, areal, impulsive, periodical, continuous, etc., be considered from the point of view of the character of the changes in the vertical structure of the geosystems. It is clear that their influences cause a strictly limited spectrum of changes (disturbances) to the vertical structure of the geosystems. In the tundra landscape region they may be grouped into nine categories:

1) thinning of the vegetative cover and the disappearance of rare plant species from phytocenoses;
2) disturbance of the completeness of the plant cover or its structure;
3) complete destruction of plant cover;
4) destruction of the moss-peat cushion, destruction or disturbance of the organogenic soil horizon and root layer;

5) destruction of the soil cover, removal of the organogenic (peat) horizon and denudation of the soils and rocks;
6) erosion of the surface to the base of the active layer (top of "permafrost");
7) planeing the surface to the top of the "ground-ice complex";
8) removal of portions of "ground-ice complex";
9) increase of vertical structure by means of earth flow and burying of the natural profile of the geosystem.

Heavy disturbances to the geosystems vertical structure (points 7-9) cause deep, irreversible changes in the environment, destruction of the natural interconnections and destruction of all types of landscapes. Activization of destructive landscape processes and phenomena (thermokarst, thermoerosion, solifluction, landslides, landslips, etc.) take place which makes it impossible to restore natural geosystems in the near future without recultivation. Weak (points 1-3) and average (points 4-6) disturbances of the geosystems vertical structure lead to different negative consequences depending on the types of landscapes on which they occur. In southern tundra landscapes on warmer and well drained sites or habitats they cause a decrease in the thickness of active layer, and a decrease of the average annual temperature of the ground. This leads to the development of bogging up processes and a gradual substitution of shrub communities for shrub-grass and grass-moss communities. typical tundra landscapes do not undergo substantial changes as a result of weak and average disturbances to their vertical structure. Here active recovery of soil plant cover, localization and attenuation of negative processes and phenomena take place.

The disturbances to the vertical structure of arcto-tundra landscapes lead to the development of deflation and internal erosion which in turn cause the destruction of vegetative cover and the removal of the lichen cover of the northern tundra. The disturbances to the vertical structure of tundra-boggy landscapes are accompanied by the destruction of the moss cushion and of the peat horizon which causes the increase of active layer thickness and the amplitude of the average annual heat turnover. Accompanying this, in some cases, is an improvement of drainage and aeration of the root zone which leads to the formation of productive plant communities. In other cases it leads to flooding of the surface and the development of numerous thermokarst lakes or hummocky terrain that complicate agricultural activity.

THE USE OF AUTOMATED EXPRESS METHODS FOR MONITORING NATURAL WATERS IN THE NORTH-WEST OF RUSSIA

I.I. Zaitseva
Institute of Lakes, Russian Academy of Sciences, St. Petersburg

The development of a system of operative biological controls for monitoring natural waters is one of the most important tasks of today. Biotesting together with bioindication is important for the determination of water quality in natural reservoirs. It supplements

physico-chemical analytical methods of integrating information on the toxicity of the water of hydrobionts, which is necessary from an ecological point of view.

When standardized methods of preparation are used, use of test-objects and the measurement and numerical expression of parameters showing different sides of life activity of organisms than biotesting provides a transition from mainly qualitative to strictly quantitative estimations of water properties. Lately the development of biotesting methods has focused on the improvement of measurement techniques which are connected with the study and development of specialized equipment.

Rapid methods of monitoring have become more and more important because they permit quick determination of water quality and permit rapid response to prevent water pollution. The rapid character and automation of the process of measurements in biotesting require special conditions for the selection of test-organisms and test-reactions that provide information on the toxicity of the water. In reducing labor and gaining time we often lose sensitivity when using this or that rapid method, for example biotesting methods that are electrical in character and applied to living organisms that display integrated reactions to complex, many-component, anthropogenic pollution. The solution is in the creation of an entire system of automated biotesting methods with the use of organisms of different levels of organization that represent interconnected links of the food chain.

As a test, the following apparatus and methods were used to estimate the toxicity of waters:

1. A biotester measuring the response of a gemotaxis of protozoa which allows them to avoid water zones with toxicants .
2. A fluorimeter for measuring slow fluorescence of algae as an index of their photosynthetic activity. Both devices were developed at the Department of Biomedical Electronics and Nature Protection of the St. Petersburg Electro-Technical Institute.
3. A bioluminometer for estimating water toxicity by suppression of the luminescence of luminous bacteria. The device was made in the Design Office "Nauka" of the Siberian Division, Russian Academy of Sciences (Krasnoyarsk).

For metrological monitoring copper sulphate and potassium bichromate were used to determine the level of sensitivity of test-organisms to the influence of toxic material. By combining biotesting primary producers (algae) with consumers (bacteria and protozoa) information can be obtained on the water toxicity for different biotic components of natural reservoirs.

Regions with different levels of anthropogenic load were studied with the use of data from automated biotesting methods under field conditions on Lake Ladoga and an estimation of water quality based on the indexes of toxicity was produced.

BIOLOGICAL INDICATION OF THE GEOCHEMICAL SITUATION IN INDUSTRIAL MINING REGIONS OF THE NORTH-EAST OF RUSSIA

M.N. Zamosh, O.V. Motorov and E.A. Tikhmenev
Russia Scientific Research Institute on Gold and Rare Metals, Magadan

The technogenic impact in development of mineral deposits greatly influences the geochemical situation of natural complexes. One of the most effective methods for indicating the degree, intensity and scale of their transformation is the study of the biogeochemical characteristics of the soil-plant cover.

The development of mineral deposits in the north-east is done by open-cut and underground methods, mainly in river valley bottoms, areas characterized by the highest biological productivity and natural-economic potential. In development of the deposits complete destruction of ecosystems takes place which causes a sharp intensification of geophysical processes recorded as: an increase of 1.5 to 3 times in the depth of seasonal melting, increases in the temperature of surface waters, the amplitude of rock temperatures and weathering rate. This determines release of chemical substances from rocks that are brought to the surface and the further migration of these substances in with seasonal melt and river waters, and their eventual accumulation in woody and grassy plants of contiguous areas. Besides the source for release of chemical substances, nitrogen combinations in particular, are the products of explosive ammonium nitrate based combinations.

The analyses of plants growing over dumps testify of the increased content of zinc, magnesium, manganese and lead compared to the normal natural background in reed grass (*Calamagrostis Langsdorfii*), meadow grass, *Chosenia*, willow, poplar and larch. Silver, manganese and sodium accumulate in *Polygonum tripterocarpum A. Gray*, and gold in *Rorippa barbareifolia (DC) Kitag*. In vegetable cultures growing on recultivated lands the nitrate content is increased up to 2.5 to 7 g/kg of dry matter; anomalous concentrations of zinc, potassium and calcium are also observed.

The development of ore deposits in a number of areas of the region leads to the formation of large technogenic anomalies produced by input of chemical substances not characteristic of natural complexes under natural conditions. The sources from which the chemical substances are mobilized are tailings from concentrating mills and the discharge of technological gases into the atmosphere. In the process of migration of substances in underground and snow melt waters they accumulate in plants. Concentrations of lead, zinc, copper, cadmium and stibium (antimony) reaching 3 to 5 g/kg of ash are characteristic of bark and trunk timber and exceed the normal background by 20 to 100 times. The greatest biogeochemical anomalies occur in areas of ground water discharge on icefields directly adjoining the sources of pollution.

At the same time regions where ore deposits are located are distinguished by a wide development of different natural geochemical anomalies. The results of our investigations

allow us to draw a conclusion about the corresponding biogeochemical situation in forest communities within areas of dispersion of natural as well as technigenic anomalies. Of considerable interest are biochemical peculiarities of grassy plants on recultivated tailings that are actively accumulating compounds of iron, copper, zinc, lead, silver and gold.

The existence of geophysical and geochemical anomalies in industrial mining regions results in both an acceleration as well as a decrease in the rates of seasonal vegetation development, changes in seed productivity, seed vigour and phytomass accumulation. The recognition of biological indicators and their use allow us to make objective estimations of existing conditions and to predict changes in environmental quality, as well as to conduct effective monitoring which permits us to undertake well-grounded solutions to the location of facilities and on mining technologies.

SECTION 5: ORGANIC AND CHEMICAL AMENDMENTS

HUMIC PREPARATIONS FOR LANDSCAPE RECULTIVATION

A.M. Abramets, O.I. Kamzolova, and I.I. Golovchits
Institute of the Problems of Use of Natural Resources and Ecology,
Academy of Sciences of Byelorussia, Minsk

Humic preparations - natural polymer products derived from peat and sapropel are ideal and ecologically safe means to increase fertility of soil systems and to speed-up cultivation of territories disturbed by economic development.

Studies were carried out on the development of soil stabilizers from peat and sapropels in order to improve soil structure and the regulation of its water and mass-exchange properties. The treatment of soil with humic preparations permits stabilization of the fine soil fraction from wind erosion by means of aggregation of the top layer. The amount of humic stabilizers needed to accomplish this is comparatively low (100-300 kg/ha.).

Coating by the humic preparations over the soil surface leads to the decrease in the rate of moisture evaporation and reduces soil salinity The mechanism involved brings about an increase of bound moisture and soil exchange capacity. Under the influence of humic preparations the content of bound moisture in soil increases. The colloid fraction of humic preparations is especially important in actively changing the water properties of the soil system. By producing soil aggregates, humic preparations increase the content of capillary moisture and simultaneously the water holding capacity of the soil system improves. The mobility of water-soluble humic preparations depends on their molecular mass. The higher the molecular mass the more it reduces ion movement in soil systems. It has been determined that humic preparations of peat and sapropel materials decrease the uptake of heavy metals and radionucleids by plants.

Our investigations defined the composition of humic preparations, the means and technology of their production and the organization for the production of humic preparations at the "Gantsevichsky" plant.

The high efficiency of humic preparations in recultivation of quarry and sand-pit areas after the extraction of gravel, clay, sand and other non-metallic minerals was demonstrated and their application volumes and conditions of their application were determined.

ANTHROPOGENIC IMPACT ON FLORA AND VEGETATION ALONG KHAR'JAGA-VOZEY-USA-UKHTA PIPELINE

N.P. Akulshina and G.S. Schushpannikova
State University, Syktyvkar

Natural flora and vegetation are important indicators for the estimation of the state and prognosis of dynamic processes directions in affected natural ecosystems. The line is a peculiar transection stretching in the southern direction. From 1978 it is a plot for detailed floristic-geobotanical investigations serving as the basis of botanical monitoring (Akulshina, 1987). Eight local floras are studied on the key plots with the application of the floristic method according to Tolmatchev. The floras are as follows: Big Synja - I (270 species), Big Synja - 2 (342 species), Malaja Synja - (259 species); Synja Nurd (336 species), Usinsk - (352 species), located in north taiga; Golovnye (349 species), Vosey (325) in forest-tundra; Ust-Khar'jaginsk (249 species) in south bushy tundra. The degree of ascertaining is 90%. The total number of species on the list is 512 from 222 genera and 63 families.

From the South to the North local floras of northern-boreal type are transformed into hypoarctic-boreal followed by the changed in boreal species from 69.7% up to 59%, hypoarctic from 9.6 to 17% and arctic from 3.8 to 8.4%. As for longitudinal groups are concerned there prevail Eurasian species - from 43.6 to 40.2% and circumboreal - from 26.5 to 30.3%. The family of caryophyllinus is markedly enriched by anthropochora (e.g. *Stellaria media, Melandrium album*), Cruciferae (*Lepidium ruderale, Thlaspi arvense*), Leguminosae (*Medicago lupulina, Melilotus albus*), Polygonaceae (*Polygonum aviculare, Phalopia convolvulus*) and this increased their importance among other families.

Vegetation is changing. Much space on the lands disturbed is given to the secondary vegetative communities in the sequences of demutation from the initial to shrubby stages of successions and next to forest coenoses. Coefficients of similarity of species composition in different vegetative communities reflect dendrit and correlating pleiades. Forest and shrubby vegetative communities are also distinguished: 1 - spruce forest (*Picea obovata*), 2 - birch forest (*Betula pubescens*), 3 - wet pine forest (*Pinus sylvestris*), 4 - larch forest (*Larix sibirica*), 5 - (*Betula nana*), vegetative communities on overflow and on disturbed lands, 6 - overflow meadows (*Calamagrostis purpurea, Alopecurus pratensis, Bromopsis inermis*), 7 - overflow willow forests (*Salix viminalis, S.phyliciflora*), 8 - shrubby willow forests on disturbed substraits (*Salix phyliciflora, S.glauca, S.lapponum, S.lanata*), 20 - wet disturbed lands (*Eriophorum scheuchzeri, Juncus nodulosus, Alopecurus aeqvalis*), 12 - dry disturbed lands (*Festuca ovina, Crepis tectorum, Chramerion angustifolium*), 13 - plantae ruderales, plantae anthropochorae (*Erysimum cheiranthoides, E.hieracifolium, Barbarea vulgaris, Raphanus raphanistrum*), 10 - plantae paludosae (*Eriophorum vaginatum, Rubus chamaemorus, Ledum palustre, Menyanthes trifoliata*), -- plantae riparius-aquaticus, aquaticus (*Butomus umbellatum, Potamogeton pectinatus, P.perfoliatus*).

As a whole synanthropisation of the vegetative cover in the region shows certain increase, some rare species and communities are lost , ecotopic and phyptocenotic variety of vegetative communities are leveled. The aims of botanical monitoring are still rather acute. They consist in the control of the vegetative cover state, prognosis of its changes and finding the ways of rational interference (control) into dynamic processes of vegetative communities aimed at the preservation of self recovery properties or their assistance by the methods of biological recultivation.

SOIL-CHEMICAL ASPECTS OF USE OF HYDROLITED LIGNIN AS LOCAL FERTILIZERS ON BLACK-ASH SOILS OF KOMI

A.M. Ammosova and O.S. Yakimenko
Lomonosov Institute Faculty of Soil Study, Moscow State University, Moscow

One of the most important problems encountered in the agricultural use of soils in the Northern regions of Russia is the low fertility of black-ash soils, caused by low humus content and the lack of organic fertilizers. The use of hydrolited lignin (HL) as a non-traditional fertilizer could simultaneously promote the decrease of the pollution of the environment and prevent the degradation of soils, as a result of the constant deficit of humus. However, as HL is an industrial waste, its agricultural use requires a study of its influence not only on the nutrient levels, harvest and productivity of agricultural crops, but also on the chemistry of soil processes, the principal physical and chemical properties of soils, and their humic state.

Joint research by Komi Science Centre and Moscow State University has been conducted in small field experiments to investigate the properties of soils with the introduction of lignin fertilizers: neutral dolomite flower with HL and lignin compost. The waste HL of The Timber Industrial Complex contained more than 49% C, about 0.2% N, 0.03% K, 0.06% P, 0.6 to 0.7% S, and had an initial pH of 2.2. Composting of HL with manure improved its properties. The manure-lignin compost contained 1.1% of N and 0.5% of K and P, and had a neutral reaction.

The content of heavy metals (Co, Cu, Ni, Zn) in the samples studied range between 4 to 50 mkg/g, which does not exceed the phono-level. Carcinogenic carbon compounds (3, 4 benzpyrene and 1, 12 benzperylen) were not discovered. The content of the basic nutrient elements in the experimental soils is being changed by the amount of the introduced substances. The major physical and chemical properties of the soils are changed under the influence of lignin fertilizers: hydrolite acidity decreases from 4.4 to 2.6 to 2.3 mg-eq/100g, and the content of exchangeable cations and buffering capacity increase. As a result of the decrease of hydrolite acidity and the increase of Ca^2 and K content in the manure-lignin compost, saturation of the soil by the bases increases from 65 to 75 to 90%. Especially significant is the influence of the lignin fertilizers on the humic conditions of the soil.

Humus of black-ash soil takes on a more humate character mainly because of the absolute increase in the sum of humic acids (HA) and decrease in the amount of fulvic acids (FA). The increase of humate properties of the soil in the experiment, evidently, results from the increased HA in the soil, such (HA) can be found in lignin fertilizers. The latter contain humic substances in their composition: manure lignin compost contains 12 to 13% of HA, hydrolyzed lignin contains 3 to 4%. The composition and structure of humic acids have been investigated and it has been shown that HA's from compost have an elemental composition similar to the soil composition. Preparations of HA from HL do not have N and have some evident peculiarities in the structure of the molecule.

SPECIAL CHARACTERISTICS OF GREENERY PLANTING IN TOWNS AND VILLAGES IN THE KOMI REPUBLIC

T.V. Bardina
Research Centre for Ecological Safety, Russian Academy of Sciences, St. Petersburg

Restoring disturbed landscapes together with their aesthetic value in urban situations is an important one. Planting of greenery in the North is labor-consuming and expensive, thus protection of natural greenery during the development of these territories is of importance because it permits the retention of an experimental (natural) effect at lower cost.

The construction of dwellings and industrial buildings and the installation of underground communications (water-supply, sewerage, telephone and electric cables) results in the disturbance of natural soils, the mixing in of debris and rubbish and often produces barren, unproductive soils. Under such conditions it is necessary to create artificial soil mixtures.

Research on this problem was carried out in Usogorsk. Natural soils there are of light, mechanical composition and are characterized by acidic reaction, low nutrient status and low stocks of organic matter. Such soils need organic fertilizers. A mixture of local peat and silt is a good organic, fertilizer, as is sewage water which contains (35 to 75%) organic matter, macro- and micro-elements, and has an alkaline reaction. These can be used immediately while compost requires a year to form.

Since there are no nurseries for growing decorative trees and shrubs we recommend the use of local plants and trees as the source for greenery in towns and settlements. These may be obtained from forest cutting sites and road and electric power line corridors. Young plants 1 to 2 m high with a symmetric crown and an erect trunk are the best planting material. They may be birch, rowan-tree, sweet-briar, black currant and other species. Planting should be done in autumn.

To solve the problems of restoration of the disturbed lands in settlements of the Komi SSR it is necessary to enlist specialists such as engineers, technicians, and gardeners proficient in such fields.

THE EFFECT OF MINERAL AND ORGANIC FERTILIZER CONCENTRATION ON POTATO AND OAT CULTIVATION ON SANDS OF THE SUBPOLAR REGIONS

A.V. Bogomolov
Agricultural Institute, Tyumen

Between 1985 and 1987 experiments were carried out at Nadym (Tyumen region) on the effects of application of four concentration levels of peat (200, 400, 600, and 800 t/ha), and two concentration levels of NPK on the productivity of potatoes and oats grown on sandy soils. In 1987 annual lupine (*Lupinus sp.*) was introduced to the 200 t/ha treatment. Peat acidity was neutralized by $CaCO_2$. Mineral fertilizers (NKP) were applied as $N_{160}P_{160}K_{160}$ for potato (var. *Belosnezhka*) and $N_{120}P_{120}K_{120}$ for oats (var. *Taezhnic*).

Mass volume and hard phase bulk density in the tilled horizon decreased with increased volume of peat, but the overall porosity decreased, e.g., the bulk density in the 0 to 10 cm layer was 1.33 $g.cm^3$ at 200 t/ha and 0.59 $g.cm^3$ at 800 t/ha. The porosity was 48.2 and 76.6% respectively. Changes in agrophysical indexes were observed a depth of 20 to 30 cm. Below 30 cm these indexes were similar to those for sands. Potato productivity increased with the increase of organic fertilizer dosage, and this is characteristic of the entire period of the investigation except in 1986 when in the middle of August the plants were damaged by the frost (Table 1).

TABLE 1

The Effect of Peat Dosage on Potato Productivity, c/ha [1)]

Variant	Action		Response			
			1st yr	2nd yr		3rd yr
	1985	1986	1986	1987	1988	1989
200 t/ha peat	75.0	18.9	39.4	118.0	96.3	128.6
400 t/ha	105.0	17.4	39.3	145.0	139.3	128.0
600 t/ha	93.2	17.2	48.5	188.0	170.0	136.1
800 t/ha	126.0	10.1	40.4	202.0	164.9	172.8
200 t/ha of peat + lupinus	--	--	--	143.0	125.0	119.9

1) 100 kg/ha

For the period of record the green mass productivity in oats was quite satisfactory and increased with the higher doses of peat. The effectiveness of mineral fertilizers was studied in combination with a peat addition of 400 t/ha. Such fertilizers as carbamide CH_4N_2O, double superphosphate (mixture of Ca $(H_2PO_4)_2$ and $CaSO_4$ $2H_2O$) potassium salt and nitrophosphate were used. Observations of the effect of nitrate nitrogen NO_2-N, phosphorus and potassium showed that during the period of germination their effect was related to the quantity of fertilizer used rather than the NPK formulation. Before harvesting of oats the difference (in productivity) related to nitrate nitrogen is less evident and is minimal in the tilled layer. In all years leaching of nutrients into the subplow soil layer was recorded. Variations in meteorological conditions during the growth period and the level of mineral plant nutrition (NPK concentration) effected in some way the harvest productivity.

TABLE 2

Output of Oats Green Mass in Relation to Mineral Fertilizer Composition, c/ha

Formulation	Green Mass 1985	1986	1987	Mean for 3 years	Extra c/ha
$N_{60}P_{60}K_{60}$	126.0	125.0	125.0	125.3	----
$N_{90}P_{90}K_{90}$	164.2	245.0	166.0	191.6	66.3
$N_{120}P_{120}K_{120}$	172.0	282.0	217.0	223.7	98.4
$N_{120}P_{120}K_{120}$ (nitrophosphate) + copper	192.8	271.0	218.0	227.3	102.0
$N_{120}P_{120}K_{120}$ + boron	189.7	266.0	229.0	228.2	102.9
$N_{180}P_{180}K_{180}$ + N_{30}	210.0	275.0	231.0	238.7	113.4
$N_{90}P_{120}K_{120}$ + N_{30} (introduction in the period of bushing)	235.8	270.0	221.0	242.2	116.9
$N_{120}P_{180}K_{180}$ + N_{30} (tubulation) (introduction of fertilizer in the period of bushing)	240.9	271.0	248.0	253.3	128.0

THE USE OF HUMUS PREPARATIONS OF PEAT FOR RECULTIVATION OF DISTURBED LANDS

V.M. Dudarchik
Institute of Problems of Use of Natural Resources and Ecology

This investigation focused the effectiveness of humus preparations, derived from peat processing, in changing the structure, water holding properties, evaporation rate, moisture absorption and ion composition in mineral and organic soils.

It has been demonstrated that for the development of clay-humic complexes is necessary to activate the processes of surface interaction between humic elements and the surface of clay materials by periodic wetting-drying, decreasing the thickness of water films on aggregates and decreasing the surface charge of clay minerals and anions of the sorbing humus elements by lowering the pH of the medium. The process of formation of clay-humus complexes in the soil is also promoted by the presence of polyvalent cations.

With regard to accelerated recultivation of the land, the process of structural melioration of mineral and organic soils, including the reduction of mineralization and leaching of necessary plant nutrients have been worked out with the use of colloidal and porous humus preparations. Tests have shown these preparations to be active in the formation of soil structure. It has also been demonstrated that for the optimal meliorative effect, both the method of introduction of the humus preparations and the proportion of porous to non porous compounds are important. The meliorants have been shown to increase the production of agricultural crops and are ecologically harmless.

THE INFLUENCE OF THE DERIVATIVES OF HYDROLYTIC LIGNIN ON THE BIOLOGICAL ACTIVITY OF AGRO-CHEMICALS

I.N. Hmelinin, V.M. Schvetsova and E.G. Nikolaeva
Institute of Biology, Komi Science Centre, Ural Division, The Russian Academy of Sciences, Syktyvkar

Recently scientific study has focused on the use of hydrolytic lignin in agriculture. Our work, conducted in the European northeast together with specialists from Russian scientific Institutes, has developed optimal methods for manufacturing lignin-based fertilizers, as well as, methods for their use on podzolic soils. It was found that lignin-based fertilizers stabilized of the soil and enhanced soil fertility.

Agrocenosis need replenishment of those elements taken away in the harvest. These can be provided, especially, by adding mineral fertilizers. Even though fertilization may increase the size of the harvest, it also produces a number of undesirable secondary effects on the soil, the ecology and the agricultural output. This study provides information on the action

of mineral fertilizers in combination with lignin fertilizers, as they affect the volume and quality of the agricultural output.

Manure-lignin compost (MLC) was introduced into loamy soils on which perennial grasses were grown along with several cultivated crops overa period of five years. For control purposes, experimental plots were established without using organic fertilizers, although they had been fertilized several years before with peat-manure compost (PMC) which was used commonly at that time in land management. The plan of the experiment was sevenfold: the basic size of each plot was 500 m^2, with 4 replications. The mineral fertilizer studies began 3 years after fertilization with organic fertilizers. On one-fifth of the area of each experimental plot, during the course of the next 3 years, mineral fertilizers were used. This brought about an increase in the yield of perennial grass hay in all cases. The main improvement (97%) however occurred in the cases where 200 and 1000 tones of MLC per ha. were applied while a sufficiently high yield of hay was attained in the control plots -2,760 tons/ha. in 1989, and with a hay yield of 5,820 tons/ha. in 1990. the additional yield (30.4%) resulted from the use of $N_{60}P_{60}K_{60}$ at the rate of 20 tons/ha MLC.

The hay yield in 1990 on the PMC plots using mineral fertilizers tuned out to be lower than on the control plots by 8%. Thus, the advantage of using mineral fertilizers on the MLC plots, compared with the traditional PMC plots, was 38.4% with a high absolute output (7,590 tons/ha). An even greater effect from the use of mineral fertilizers on the soil with the 5-year old MLC was seen in the production of turnips.

These effects result from the changes in several related factors as a result of lignin compost: the reduction in soil density is reduced and as a consequence, its water holding capacity and aeration increase; micro-flora and meso-fauna activity increase. It is important to understand that for different crops this effect varies: the more demanding the crop, the more influential the effect.

Consequently, under the influence of MLC, the changes in soil properties lead to better growth conditions for the more demanding crops. Moreover, as a result of the increase in the biological activity of the soil, the organic cycling of elements also increases, which indirectly indicates increased utilization of elements from the agrochemicals. This is not only economically important but is also ecologically beneficial. The data thus gathered constitute the basis for the creation of regulated agrocenosis in the North.

RECULTIVATION OF SANDY SOILS AND THEIR AGRICULTURAL UTILIZATION IN THE POLAR REGIONS OF WESTERN SIBERIA

Z.N. Karetin
Agricultural Institute, Tyumen

In the near future the population of the developing oil-gas regions, located in the forest-tundra zone, north and middle taiga, will reach 2 million people. The population of those regions and specially the regions of gas-development, in the north taiga and forest tundra zones are supplied with agricultural products which come from the southern regions of the country. Analysis of climatic conditions shows that even in the extreme conditions of the Subpolar region the majority of products of husbandry and animal breeding can be obtained there and quite successfully at that.

In the regions of gas-development situated in the north taiga, the soils are represented by podsolic-gley soils together with sandy soils which are considered to be rather marginal for cultivation. The climatic conditions are characterized as follows: annual precipitation is 430 m with 240 mm falling in the summer; the total degree days are 800 to 1000°; vegetation period is 95 to 105 days; frost-free days - 70 to 80.

Investigations conducted by the department of Soil Science and agrochemistry of Tyumen Agricultural Institute between 1983 and 1990 showed that even when traditional methods of soil cultivation are used, yields obtained for many varieties of crops on recultivated sandy soils are not lower than on rich, fertile soils of the southern parts of the region.

The basis for recultivation is the application of peat in an intermediate stage of decomposition, normally at 400 to 800 t/ha. depending on the crop; dolomite powder or lime at 8 to16 t/ha. and mineral fertilizers, at a rate of 120 to160 kg of NPK per ha. Under such conditions yields were: potato - 100 to 150 c/ha (in favorable years without autumn frosts up to 200 to 250 c/ha.); pea-oats green mass - 200 to 280; cabbage - 200 to 400; carrot and beat root - 60 to 70; reddish 80 to 90 c/ha. Silage crops also appeared to be productive. With the introduction of limed peat at 800 t/ha. and NPK in the amount of 90 kg in water-application the yield of turnips was between 330 to 680 c/ha. of biomass including root plants at 220 to 440 c/ha; swede Kuuzic (*Cruciferae*) from 440 to 540 c/ha. as seedlings; root plants included carrot and beet root produced small crops 140 to 260 c/ha.

Under the extreme conditions of cultivation in the Subpolar regions the type (variety) of the plant is of great importance. The variation between early varieties of potato and those of midseason (intermediate) is 1.5 to 2.0 times greater on the experimental plots. This applies to other cultures as well.

Under boggy conditions more positive results were obtained with perennial grass on recultivated soils. Four hundred tons of peat, 8 tons of lime powder and 90 kg of NPK per hectare were introduced on shady soil without watering. On the 2nd and 3rd years of

growth the following crops were obtained: Hungarian brome grass (*Bromus inermis*) sown as a monoculture, timothy grass (*Phleum pratense*) and reed canary grass gave 25 to 30 c/ha of hay. Reed canary grass does not survive in dry weather.

Higher and more stable crops were obtained from mixtures of Hungarian brome grass (*Bromus inermis*), meadow grass (*Poa pratensis*), timothy grass (*Phleum pratense*) and Devil's grass (*Agropyron repens*). Orchard grass (*Dactylis glomerata*), white clover, red clover and alfalfa disappear almost completely in the 3rd year after planting. With the use of irrigation it may be possible to get higher and more stable crops, and this is strongly recommended.

It is concluded that under the conditions of the Subpolar zone it is possible to get satisfactory crops of almost all field varieties, except for cereal crops cultivated in the south of the Tyumen region. Further development of cultivation techniques and non-standard methods for recultivation of sands are required.

ECOLOGICAL PROBLEMS OF DRILLING OIL WELLS AND THE BIOLOGICAL RECULTIVATION OF TERRAIN

I.V. Kosarevich and A.V. Karaseva
Institute for the Problems of Use of Natural Resources and Ecology, Russian Academy of Sciences, Minsk

At present about 2/3 of the total volume of oil well drilling is conducted in difficult climatic and geological conditions (Eastern Siberia, Far North, etc.). In the drilling of deep oil wells a variety of different liquid and solid waste materials are produced that cause significant ecological impact in the environment.

Significant technical, economic and ecological problems occur while drilling oil wells in Eastern Siberia and the Far North. During the drilling processes the problem arises of supply of drilling complexes with the necessary building and construction materials for deep well drilling. In permafrost regions the annual volumes of extracted solid minerals is 450,000 m^3. The total use of clay solutions (drilling solutions) is more than 100 m^3, and to prepare them 40,000 tons of clay powder is necessary plus a significant quantity of chemical reagents. The cost of clay powder is 35 to 40 rubles (1991) per ton, and transportation costs are 100 r/t. All the waste products resulting from oil well drilling are concentrated in the ground (pit) storage without any reliable hydroisolation. The questions of recultivation of such disturbed lands have not been solved. In the Tyumen region alone there are several thousand storage pits, which are a continuing source of pollution in the environment.

The Institute of Problems of Use of Natural Resources and Ecology of the Russian Academy of Sciences, together with several of other institutes and research organizations, have developed a harmless technology for drilling oil wells, which has a minimal ecological impact on the environment. It was suggested that peat, silt and waste products of the peat

industry be used to prepare drilling solutions. Solutions with excellent properties can be prepared during the dispergiration of peat and silt in the presence of 0.2 to 0.4% of alkali. Industrial tests of peat and silt solutions during drilling of about 100 wells for oil, gas and solid minerals and mineralized waters have demonstrated the effectiveness of the new technology.

The high absorbency and ion-change properties of peat and silt are the reasons for their wide use in purification of the water, containing chemical reagents, oil products, solvents of heavy metals, etc. In peat and silt there are bacteria of different kinds, which create favorable conditions for purification of soils. When the pollutants are subjected to biodestruction, harmless products are formed.

The role of peat and silt in recultivation of drilling sites after removal of the wells is great. With the use of peat, silt and mineral fertilizers, soils are created that are useful for agricultural needs. When seeding grasses it is necessary to introduce bacterial preparations into recultivated soil.

BIOLOGICALLY ACTIVE GRANULAR FERTILIZERS USED FOR RECULTIVATION OF TECHNOGENIC LANDSCAPES

Yu.M. Markarova, V.O. Gromova and I.B. Archegova
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktyvkar

One of the main characteristics of tundra and taiga soils is a thin organo-accumulative layer, that is easily destroyed by any technogenic disturbance. The process of its reconstruction is very difficult. One of the considerations of biological recultivation is to develop a number of approaches suitable for the reconstruction of the biogenic-accumulative layer. The approaches of biological recultivation used at present such as "earthing" and the introduction of mineral fertilizers with and following seeding are expensive and labor intensive. In the following paragraphs the results obtained from studies of the effect of biologically active granular fertilizers on plant growth and development are given.

Biologically active granulars (granular fertilizers) are primarily organic substrates, the basis of which is microbiologically processed lignin - the remains of wood production. Before granulation the lignin is mixed with the seeds of perennial grasses and inoculated with bacterial preparates (mizarin, flavobacterin, nitrobacterin). The biological activity of the granules is preserved by drying and freezing. This allows storage and transport of granulated fertilizers, and we think this is a good reason to test late autumn seeding.

Laboratory evaluation of the granulates gave positive results: perennial grasses produced earlier brairds displayed better adaptivity and growth rate. The biological activity of the granulates and substrate was estimated by respiratory rate (CO_2 production)

According to the data obtained, the technique of recultivation of technogenic territories with the help of biologically active granulates is considered to be worth looking into.

SUCCESSION CONTROL IN SELF-REVEGETATION IN FOREST-TUNDRA

B.M. Mirkin and A.F. Khusainov
Bashkir State University, Ufa

The management of anthropogenic succession is an effective way to increase the productivity of artificially seeded meadows. In the North this attention is given not to the seeding of grass mixtures but to the stimulation of the development of local flora species and acceleration of natural revegetation processes. The main way of controlling succession is through the introduction of mineral fertilizers, just as it is in the cultivation of meadows. The introduction of nitrogen fertilizers is especially effective because it accelerates the tillering of grasses.

To study different methods of succession control an experiment was started in 1988 on the area of Yernik. In this area low birch thicket-willow-shrub tundra had been disturbed in he course of the construction of gas-extraction facilities in the region of the Medvezhye field. The experimental site supported a 40 percent cover of natural revegetation developed in the 3 years after the disturbances had stopped. The experiment consisted of 2 variants, a control and mineral fertilization ($N_{30}P_{30}K_{30}$) repeated 2 times. The size of a plot is 100 m^2. Results are given in Table 1.

TABLE 1
Influence of fertilizer on the composition of regenerating vegetation.
Values are in %.

Indications of Vegetation	1988	1990	
		Control	Fertilizer
Total projective cover	40	45	80
Sodding	10	15	40
The cover of separate species:			
Festuca Ovina	5	5	25
Deschampsia sukachewii	10	10	20
Calamagrostis lapponica	7	10	10
Equisetum arvense	5	5	10
Chamerion angustifolium	7	5	10
Carex globullaris	3	5	7
Luzula multiflora	1	3	3

The experiment permitted us to access the effectiveness of fertilization as a way of managing autogenetic succession. From Table 1 it is clear that grasses responded strongly to fertilization. We believe that this method will be effective in the recovery of disturbed sites where the upper layer of soil horizons is preserved and there is a sufficient seed bank of serial species.

Because it is possible to apply mineral fertilizers using helicopters or airplanes we believe that this way of controlling succession is widely applicable in programs for the recovery of tundra and forest tundra disturbed by oil and gas-extraction.

INVESTIGATIONS OF THE COLLOID-CHEMICAL PROPERTIES OF QUARTZ-GLAUCONITE SANDS WITH RESPECT TO THEIR APPLICATION IN LAND RECULTIVATION

Z.M. Petrova and N.S. Ostapenko
Institute of Agrophysics, St. Petersburg

At present one of the methods of increasing soil fertility is to incorporate into soil geological rock wastes from the mining industry. It permits the use of these waste materials without environmental damage.

The investigations were carried out on the colloid-chemical properties of quartz-glauconite sands. These appeared to be most effective on heavy (clay rich) soils with low permeability and weak gas exchange. Estimations were made of the physical and chemical properties. The electrical conductivity was determined for quartz-glauconite sands from different areas, as well as, heavy soil and soil quartz-glauconite mixtures.

Quartz-glauconite sands (mechanical composition: sand 55%, silt 18%; physical clay size material 12%) show a significant coefficient of filtration, low electrokinetic potential and a low surface charge. These properties permit them to be introduced as meliorants into heavy soils. Their high content of potassium, calcium, phosphorus and a low content of zeolites make it possible to apply them as a mineral fertilizer. The investigations showed that the introduction of quartz-glauconite sands into heavy soils resulted in decrease in pH which is the result of Ca^{+2} and OH^- and also with Na^+ and K^+ replacement from PPK. The decrease of electrokinetic potential and surface charge of the solid phase of the soil was conditioned by changes in the structure and properties of the double (electrical) layer close to the (clay) surface, and an increase in soil adsorption. The introduction of quartz-glauconite sand improved infiltration and the structural characteristics of heavy soils.

These investigations showed that it was possible to apply quartz-glauconite sands to disturbed and exhausted (nutrient poor) lands for effective recultivation in an ecologically sound way.

ADVENTIVE ROOT-FORMATION IN LARCH UNDER NATURAL AND EXPERIMENTAL CONDITIONS

V.P. Putenikhin, D. Evald, L. Kuhler, and P.D. Andrianov
Botanical Garden, Bashkir Science Centre, Ural Division, Russian Academy of Sciences, Ufa, and Institute of Timber and Forestry, Graupa, Valdzieversdorf, Germany

Larch is one of the most promising coniferous species for cultivation on technogenic landscapes of the North. A solution to the problem of vegetative propagation, rapid growth and resistance to industrial pollution is vital.

On the Altai (region) adventive root-formation was established on low branches of 40 to 80 year old larch-trees (*Larix sibirica*). In the Alpine population (1800 m above sea level in a thin foliage forest at the boundary with alpine tundra) root-formation was established on 4.3% of the trees. Here root development is taking place when branches are being covered by wet moss-lichen vegetation that includes *Pleurosium Schreberi (60%), Rhytidium rugosum (35%), Cetaria cucullata (5%)* and in rare cases *Dicranum scoparium.* The formation of rooted layers was observed previously in Sukachevi larch (1.5% of trees) on boggy open places in the middle Urals. We suggest that the regenerative potential of shallow-rooted species is somewhat increased in extreme conditions.

An experiment was conducted by implanting green cuttings of Sukachevi larch (*Larix sukaczewii*) from the alpine population of the southern Urals (1000 m above sea level). The cuttings were taken from 80-year old plantings from 10 trees in the initial period of sprout lignification. Three variants of cutting treatment using phytohormonal powder mixtures, developed by specialists in Germany, were tested. Stimulation of rhizogenesis took place in a (3:7) peat-vermiculate substrate under conditions of artificial fog (misting), in a mini-hot-house with a polyethylene cover placed inside a glass green-house. The experiment was repeated four times.

Only one variant of treatment (indolil-3-oil acid with orthocid in talc carrier) was a success. After 3 months the effectiveness of implanting ranged from zero to 18.2 percent and averaged 5.4 percent. According to literature, in laboratory experiments with American larch (*Larix laricina*) the rooting (striking) of cuttings taken from 19 to 41 year old trees was achieved in 23 to 93 percent of the cases (Carter, 1984). In other investigations root formation was observed in trees with ages between 2 and 13 years.

In our study only four trees out of 10 showed the ability to form adventive roots. On the basal cut, of the cuttings, callus excrescence formed, out of which, as a rule, one fragile white colored root, 1 to15 cm long formed. Thus adventive rhizogenesis was not physiologically of significant value, as the relations between sprout and root through callus are far from perfect. Evidently this was the main reason of further dying off of the rooted cuttings.

Nevertheless the data on natural root-striking of branches and the results of our experiments on induced root-formation under artificial conditions provide evidence for the possibility of autovegetative propagation of mature larch species.

THE INFLUENCE OF FERTILIZERS ON THE DEVELOPMENT OF BELOWGROUND AND ABOVEGROUND BIOMASS ON SLOPES SUBJECTED TO THE EROSION

L.P. Shishkina and O.B. Sygnalova
Lomonosov Research Institute of Moscow State University, Moscow

Over the past several years studies have been conducted in northern Siberia on the acceleration of natural regrowth of vegetation on slopes subjected to erosion, as well as, the development of an artificial cenoses on such slopes. Plants possessing good anti-erosion properties that are also prospects for biological recultivation were studied. A series of experiments were also conducted to study the influence of fertilizers on the development of above and belowground plant biomass on slopes subjected to erosion. The investigations were conducted on sites where the vegetation consisted mostly of crops. The experiment was conducted with fertilizers (NPK) and without fertilizers (control). These studies have shown that by autumn on the fertilized site, the belowground biomass increased approximately 1.3 to 1.4 times compared to "control". The largest net growth was noted in the upper 0.2 cm of the soil.

On the fertilized experimental sites the accelerated growth of crops was observed, especially for *Poa pratensis*. In addition to the more vigorous growth of the vegetative shoots of the crops (compared to "control"), the number of generative shoots increased which suggests a higher growth capability of the cenosis of the experimental site, compared to "control".

Thus, the introduction of fertilizers during biological recultivation creates favorable conditions for growth of above and belowground biomass, which increases the antierosion properties of a particular cenosis.

SECTION 6: UNDISTURBED ECOSYSTEMS

PRODUCTIVITY AND STABILITY OF CONIFEROUS FORESTS IN THE NORTHERN TAIGA

K.S. Bobkova
Institute of Biology, Komi Science Centre, Russian Academy of Sciences, Syktyvkar

As a rule under the conditions in the northern taiga of the European part of the Russian coniferous forest, spruce forests form mixed stands. They are characterized by low density (0.3 to 0.7) and belong to quality classes IV, V, Va. In natural stands trees vary according to their age, diameter and height.

The spruce forest is represented by green-moss and sphagnum groups. Coniferous phytocenoses of the green-moss group of forests accumulate about 30 to 50 t/ha of organic residue by the 30th year of their growth. By the time of maturity these figures are between 120 and 140 t/ha. In bogging-up types of forests the stock of phytomass is between 56 and 115 t/ha. In spruce communities phytomass accumulates from 1.6×10^{12} up to 2.5×10^{12} Dj ha of heat energy, and in pine forests from 1.1×10^{12} up to 2.7×10^{12} Dj ha^{-1} of heat energy. The main part of this energy is fixed by the tree stands. Current growth of wood-crone organic mass in coniferous stands within their ecological range in the north taiga ranges from 2.0 up to 4.5 t/ha. Although, the coefficient of FAR accumulation is rather large, the efficiency of its utilization is low, not above 1.2 percent.

Spruce and pine forests of the region under investigation are self-regulating, self-monitoring ecological systems. The stability of these forests in the boreal taiga is explained, to a large extent, by the character of *Picea obovata* and *Pinus sylvestris* as soil formers and major transformers of physical media of north taiga biogeocenosis.

In a spruce forest the tree-stand is the most stable part of the population and consists of specimens the age of which ranges from 70 to 200(300) years. The long life cycle of spruce and pine forests results from the adaptive ability of natural spruce and pine populations to extreme temperature conditions. The growth of vegetative organs in these species starts late, is rather intensive and goes on at relatively low positive air and soil temperatures. In winter they do not show mass die off of roots although the temperature of the organogenic horizon in the north taiga drops to -11° and in the middle taiga to -6°C and the life cycle of uptake roots is 7 and 9 years correspondently. The sucking strength and respiration intensity of these roots at rather low positive temperatures on moist soils are characterized by high indexes.

The stability of the coniferous biogeocenosis under the conditions of North are also explained by special characteristics of the debris layer. This organogenic horizon is an important and necessary accumulator of nutrient elements. Large total stocks of nutrient elements in the debris layer are several times more than the increasing annual requirements

of phytocenoses and should be considered a necessary condition for the successful functioning of spruce and pine biogeocenoses.

SPECIFICITY OF SOIL HUMUS ALAS OF LENO-AMGINSK INTER-RIVER AREA

M.I. Dergacheva[1)], D.D. Savvinov[2)] and M.V. Okoneshnikova[3)]
[1)]Institute of Soil and Agrochemistry, Siberian Division, Russian Academy of Sciences, Novosibirsk
[2)] Department of Nature Preservation, Yakutsk
[3)] Science Centre, Russian Academy of Sciences, Yakutsk

The preservation of natural ecosystems of the North and their local monitoring requires the accumulation of a data bank characterizing the composition and properties of all components of natural environment including soils. The small amount of knowledge of the alases (meadows) soils of the Leno-Amginsk inter-river (divide) area limits our estimation of their properties, our ability to develop mapping schemes that portray their resistance to technogenic loads and to scientifically predict their behavior under conditions of anthropogenic stress. The resistance of any system as a whole may be considered as an integrated sum of resistance of its separate components (Ryumin, 1986). The role of humus, one of the soil components, is essential in maintaining a dynamically balanced steady state (Dergacheva, 1989). The small amount of data characterizing soil humus meadows (Desyatkin, 1984) does not show the uniformity of its (soil humus) behavior under different conditions of soil development.

The study of soil humus using a profile development approach in mature small alases with clearly expressed annular zones has shown that with distance from the lake (or pond) water line both plant communities and soils change in response to decreasing soil moisture (bog-meadow-steppe) and the composition and properties of the soil humus changes from humatic in the boggy zone to fulvo-humatic in the steppe zone. The complexity of humic acid macromolecules changes in the reverse direction.

The composition and properties of humus are heterogeneous within the soil profile and reflect the history of soil formation and development as they are related to alas dynamics, relief , moisture and processes of cryoturbation. The change in the properties of the humus, together with their arrangement within different horizons and sub-horizons record the stages of development for each soil.

CREATION OF A UNITED NETWORK OF NATURE PRESERVES AND APPROACHES TO THE FORMATION OF REGIONAL SYSTEMS

L.S. Isayeva-Petrova and S. Ye. Karaseva
Russia Science Research Institute of Nature Preservation and Reserves, Moscow

A network of especially preserved natural areas including forest reserves, national parks, registered places and nature monuments must guarantee the preservation of the natural variation of the country and maintain the natural process. These tasks can be fulfilled only by the formation of the network on a nation wide scale. The Science Research Institute is developing a prospective net of preserved natural areas on the basis of suggestions of the State Committee on nature of the Union Republics. A scheme has already been developed for the apportionment of preserves and national parks for the period to the year 2000. The next stage is the development of regional networks of preserved areas. The formation of such a system is based on a complex analysis of natural and socio-economic conditions that are specific to one or another region.

The following paragraphs outline the major points for the creation of the system of nature preserves in the northern region of the European part of the country, this includes Murmansk, Arkangelsk, Vologda regions and the Karelia and Komi republics. The special feature of this region is that the boundary between tundra and taiga zones lies within that territory. At present there are 7 preserves in the region covering the total area of 1269.7 ha, or 0.87% of the area. Zonally representative preserves are in the west and east of the region. Included in the project of the national network are six new preserves covering an area of 6110 ha (4.16%) and nine national parks with an area of 2500 ha (1.7%). Thus by the year 2000 the total area of nature preserves and national parks will be 9877.7 ha (6.7%). including 4879.7 ha (3.3%) on the mainland.

One of the principles that govern the distribution of preserves is based on what natural function they preserve or represent, thus, it is necessary to guard typical zonal and unique natural complexes. Nevertheless in the perspective network the creation of preserves in the broad taiga physico-geographic Mezen-Dvina province and the distinctive geomorphological Timan province is not planned.

Another principle involves the scientific-informational function of the preserves. Preserves, situated in the centre of zonal areas, give information about the progression of natural processes under typical zonal conditions, and on the zone borders about the natural processes in the contact area or ecotone.

According to the climatologists' data a rise of mean hemisphere temperature of about 2°c is forecast for the middle of the 21st century. It is known from the reports of paleogeographers that in some regions the mean rise will be higher and in the Arctic it will reach 8°c. Such an increase can create conditions for planting trees in those regions. Potential zonal shifts may reach several degrees of latitude. The scientific-informational

role of those preserves, in the light of these data, is very important. However, along the zonal boundaries there are no nature preserves and new ones are not planned. These gaps can be filed since in the zones already mentioned and along the zonal boundaries there are a number of cedar preserves and relatively well kept areas which need protection. It would be timely to choose the more suitable of them for preserves. That would create a complete body of the system (network) of nature preserves of the region.

WATER CHEMISTRY OF THE RIVERS OF THE TUNDRA ZONE

L.G. Khokhlova
Institute of Biology, Komi Science Centre, Ural Division, Russian Academy of Sciences, Syktavkar

In this report we present an analysis of the chemical composition of the water of the rivers formed within the permafrost zone. During the summer-autumn low-water periods of 1991 the Kara and Vorkuta Rivers were studied as well as a number of their first and second order tributaries: the Narmayakha, Silovayakha, Khalmer-Yu and Sir-Yaga. Data on water chemistry within this region is minimal. Currently the Vorkuta is the only river from which water chemical analysis are taken regularly. The water chemistry of the other rivers has been determined from the results of this study. The Khalmer-Yu River and the upper reaches of the Vorkuta are very shallow with rocky and generally dry river beds.

The chemical composition of the Kara and Narmayakha Rivers and Lake Chirata was dominated by bicarbonate (more than 50% of the overall ion count). The percentage of sulfate ions was no more than 20%. Among the cations was sodium. Likewise, on the upper reaches of the Kara River the water had a sodium bicarbonate character with water mineralization not exceeding 100 mg/l^{-1}. In the Silovayakha River and below the falls On the Kara River, the mineral content of the water increased, and its chemical make-up was mainly comprised of sulfate ions. The waters of the Khalmer-Yu River also fell into the category of those rivers high in sodium bicarbonate with a mineralization of 276 mg/l^{-1}.

The practically colorless water (the color of the water was between 1° and 4°), water of low permanganate (1.63 to 5.90 mg/l^{-1}) content, and water of low oxidizability indicate that the waters of Kara River basin are poor in organic substances, quite the same as with biological elements. The content of ammonial nitrogen and free iron comprise 0.12 to 0.23 and 0.05 to 0.24 mg/l^{-1}, respectively.

The mineral content of the water of the Vorkuta River was in the range of 216-352 mg/l^{-1} and bicarbonate ions predominated. In comparison with other rivers under study, there was a high proportion of chlorides in the water (up to 22 mg/l^{-1}). The concentration of cations remained between 15 to 22 mg/l^{-1}, however, closer to the mouth, an increase in the proportion of sodium ions was noted.

The anthropogenic factor significantly affects the chemical composition of the Vorkuta River water. The coal producers are the basic polluters of the basin. Furthermore, the Vorkuta River takes in waste water from smaller business operations, household wastes and rainwater runoff. A significant portion of the waste waters is dumped without any purification or , certainly, with inadequate purification. In the region of the city of Vorkuta and downstream from it, the river is extremely polluted: the bottom is covered with black mud, in the form of a hard layer; the water is turbid with a large quantity of suspended materials. In places, floraform waters and the growth of a large quantity of thread-like water plants were observed. The low concentration of dissolved oxygen in the water and even its lack during its frozen period results in an increase in mineralization (up to 1000 mg/d-m^3 and higher). This is due to the sodium and chloride ion content, contributed by the mine waters. All of this testifies to the worsening of the water quality in the main course of the Vorkuta River.

In recent years there has been a marked increase in the content of ammonial nitrogen to the point of fish kills. Now it is common that phenols, synthetic surface-active substances and heavy metals reach the limit of fish tolerance.

In summary then, in the permafrost zone there is a characteristic increase in the mineralization of the surface waters, predominately by alkaline and low pH acidic minerals. In contrast with the rivers of the northern part of the continental tundra, the Kara, Khalmer-Yu, upper Vorkuta Rivers, the Vorkuta River in the region of the city of Vorkuta and down stream from it has lost its natural state in response, to the increase in anthropogenic pressures.

ARMOR-CLAD MITE AND THE LICHEN GROUND OF THE NORTHERN SHORE OF THE VARANGER FJORD

E.N. Melekina[1)] and L. Laskova[2)]
[1)]Institute of Forestry, Russian Academy of Sciences, Moscow
[2)]Institute of Forestry, Petrozavodsk

The armor-clad Mite is one of a group of invertebrates that play an important role in the decomposition of the organic component of the tundra flora (Chernov et al, 1971; Chernov, 1973; Krivodutsky, 1976). Lichens are the usual habitats for many forms of mites. The armor-clad Mite inhabits soil lichens which often dominate the vegetative cover of various forms of tundra. These mites have been recorded by others in lichen groups of various communities and regions.

The mite fauna of the ground lichens *Cladina arbuscula*, *Cetrari islandica*, *C.nivalis* were studied. These materials were gathered by L.G. Byazrov in dry, moss-lichens of the wasteland of the northern shore of the Varanger-Fjord (Norway) during the spring of 1989. Armor-clad Mites of ten different types were found: *Carabodes marginatus*, *C.subacticus*,

C.labyrinticus, *Oppia unicarinata*, *Banksinoma lanceolata*, *Scheloribates confundatus*, *Melanozetes mollicomus*, *Trichoribates trimaculatus*, *Achipteria coleoptrata* and *Pergalumna dorsalis*. Several samples of mites of the families *Belbidae* and *Galumnidae* were found, but not distinguished by individual type. The largest group of mites was *Carabodes marginatus*, which accounted for 74% of the total mite population in the layer of *Cladina arbuscula*; 88% in *C.islandica* and 84% in *C.nivalis*.

The majority of the mites found in these lichens (excluding *Oppia unicarinata* and *Banksinoma lanceolata*) are typical inhabitants of the surface layers of soil and its (lichen) covering. Strongly sclerotized coverings protect them from drying-out and over-heating. *Oppia unicarinata*, *Banksinoma lanceolata* are inhabitants of near surface soil interstices. The Armor-clad mites encountered in the soil lichens had been noted previously by other authors in lichen groups of various communities and regions.

RIGHTFUL PRINCIPLES ON NATURE PROTECTION AND THE RATIONAL UTILIZATION OF NATURAL RESOURCES

V.A. Molchanov
State University, Syktyvkar

In this time of scientific-technical revolution, more and more, mans activity intrudes on nature, often unreasonably or unwisely, and sometimes causes unrestorable damage. The natural systems of the North and their separate components are especially vulnerable and that is why the problem has acquired a special urgency.

Current laws provide for rational utilization and protection (of these natural systems) by means of penalties for:

1. Land: self-willed seizure;
2. Subsurface of the earth and continental shelf: violation of rules of exploitation of mineral wealth and registering by the state of extracted gold, violation of legislation on the continental shelf of Russia;
3. Water and air: air pollution and pollution of water reservoirs; pollution of the sea with substances or waste material harmful for human health and that of living sea resources ;
4. Animals: illegal fishing and other water catch trades; illegal catch of fur-seals and beavers; timber rafting and explosions that violate the rules of protection of fish reserves; illegal hunting; sale; buying or exchange of skins of fur bearing animals;
5. Vegetation: the intentional destruction or damage of state or social property; careless destruction or damage of state or social property; violation of rules on the application of chemicals for the control of diseases and plant pests; intentional damage to seeded fields and field-protective plants; illegal forest cutting;
6. Natural objects under state protection: the intended destruction, ruin and damage of cultural and historical monuments.

The objective side of such crimes may be actively expressed, for example the lack of protection for constructions and other installations on the continental shelf, the non-acceptance of measures for the protection of living sea resources from harmful wastes involves criminal responsibility according to article 167^1 of the Criminal Code of the Russian Federation.

The subjective side of the crimes is characterized, as a rule, by intentional guilt (for example, in intentional destruction and considerable damage of large forest areas by arson, illegal fishing and other water catch trades, illegal hunting, the sale, purchase or exchange of fur-animal skin). Separate crimes are committed intentionally (article 223) of the Criminal Code of the Russian Federation; the pollution of air and water reservoirs or only carelessly (article 99) the destruction or considerable damage of large forest areas as the result of careless handling of fire.

The perpetrators of crimes in the area of nature protection and the rational utilization of natural resources are Russian and foreign citizens or persons without a citizenship who have reached the age of 16. A 14-year old person is held responsible for a crime in case of intended destruction or damage of large forest areas by arson. The perpetrators of crimes under consideration may be private persons as well as officials, for example, in the violation of laws pertaining to the continental shelf.

NUMTO - A UNIQUE NATURAL HISTORICAL COMPLEX IN WESTERN SIBERIA

P.S. Sitnikov, S.P. Arefyev, O.I. Marakulina, and D.E. Lomakin
Tyumen Regional Local Lore Museum, Institute for the Problems of the Northern Development, Siberian Division, Russian Academy of Sciences

In August-September, 1990, a scientific expedition under the aegis of the Tyumen Regional Local Lore Museum worked in the environs of Lake Numto, Beloyarsk region, Tyumen oblast. During the expedition a collection of plants and insects was made, the quality of cedar cones was studied, and a number of other observations were conducted. An extensive amount of cinema- and photo-material was taken.

The results of the expedition showed that the area around lake Numto is a unique natural historical complex. It is one of the last large areas in western Siberia that is almost untouched by the industrial development. It is the key part of the watershed where the largest tributaries of the Ob - Kazym, Pim, Tromegan and other rivers have their sources and regulates, as well, the deep Nadym River that flows directly from the lake. There is no other place in the country where the flat tundra landscapes penetrates so far to the south: here is a zonal ecologo-geographical anomaly in the shape of "tongue". As a result plant and animal life is diverse.

Around the lake are cedar parks which are most unusual for the plains. A large number of cones was recorded that contained seeds of good quality. Unique cases of cone formation on short 25-year old cedar trees were also recorded. Berry fields (cowberry, bilberry, cranberry) growing along the watersheds have comparatively high productivity. They are good for large-scale storing and make up a good food base for animals. On the lakes such rare birds as swans, the white tailed sea eagle, and others are seen.

Lake Numto itself is of special value. It is characterized by good quality water and due to peculiarities of the relief of its bottom it is good for winter fishing, especially for *Coregonus peled*. It is necessary to conduct large-scale ichtyological and hydrobiological investigations on the lake.

The local population, the Nenets, have from ancient times considered Lake Numto as a holy place (the name Numto is translated as heavenly or celestial). The isle in the middle of the lake served as a cult place. Here were discovered ancient metal articles and coins. The population of the Numto settlement have kept national traditions and trades.

The results of the expedition allow us to recommend the area of Lake Numto together with the sources of the large rivers, as a natural preserve territory (park) with traditional family activities, as a base for scientific research, and possibly for foreign tourists. This region also is of interest for foreign investigators. In the summer of 1990 a specialist from Canada visited the Numto settlement. The organization of such a preserve territory will bring about great ecological and economical benefits.

FROZEN SOILS OF THE NORTHERN BAIKAL: THEIR RATIONAL EXPLOITATION AND PROTECTION

V.A. Vtorushin and N.N. Pigareva
Buryat Institute of Biology, Siberian Division, Russian Academy of Sciences, Ulan-Ude

Three types of the soil-ecological formations have been identified: Cryoaridomorphic, cryomorphic and cryolitomorphic. The soil of each formation is marked by its principal process of soil formation, turfal, black ash, humic. There are definite identifying parameters: 1) type of water conditions - non-washing (non-leached), washing (leached), freezing; and 2) temperature conditions - deeply frozen, long lasting seasonal frost, and frozen.

Every formation requires a specific method for its use, for example: cryoaridomorphic formations require irrigation, cryomorphic, organic and mineral fertilizing, and cryolitomorphic a modification of temperature conditions.

The cryolitomorphic formation includes frozen soils, meadow soils, humic and other kinds of soils, useful for agricultural development. Frozen soils are marked by a very high humic content, high potassium content, neutral reaction, natural moisture and require heating. Upon tilling the thaw increases from 1.1 to 2.5 meters. The exploitation of the frozen soils creates some negative effects, for example, the soil becomes boggy and it is necessary to take this fact into account. Recultivation of such soils is necessary on the territory of the northern Baikal.

RESOLUTION OF THE INTERNATIONAL CONFERENCE "THE DEVELOPMENT OF THE NORTH AND PROBLEMS OF RECULTIVATION" (JULY 8-14, 1991, SYKTYVKAR)

THESES OF REPORTS

The Russian Academy of Science, Ural Division,
Komi Scientific Center, Institute of Biology

The participants of the Conference consider it to be up-to-date and note great theoretical and practical importance of the investigations published in the abstracts and presented in the reports and oral presentations. Economic development of the North is in obvious contradiction with resource-and-life-providing possibilities of the region. In the framework of the departmental approach to nature utilization the fact that it can be socially effective only under conditions of its being ecological is not taken into account. The ecosystems of northern regions are most sensitive and not so easily recultivated. This is the reason why the North with its great raw material potentials must be the zone where the problems of a balanced nature-society coexistence should be solved.

At the conference more than 60 reports were presented. The participants of the conference accepted the following recommendations:

1. To hold conferences on the problems of reconstruction and recultivation of northern ecosystems once every three years under the title "Problems of Northern Ecosystems Reconstruction". In the intervals to hold working seminars in different geographical points on some definite plots with the participation of representatives from different regions, but with the total number not more than 40 persons.

2. To set up an International Commission on the problems of northern ecosystems reconstruction. To approve the suggestions of the Organizing Committee of the Conference on its preliminary personal membership. To ask the Organizing Committee to collect additional suggestions on personal candidatures from the institutions and enterprises concerned, and to decide the expedience of their membership on the Commission. To provide conditions for the working organs of the Commission in the Institute of Biology, Komi Science Centre of the USSR Academy of Sciences and Syktyvkar State University.

3. To ask the Commission to accept the status of a juridicial body and open a credit in the State Bank; to make all possible attempts to set up an ecological fund for the peoples of the North. To make contacts with international, state and public organizations with the same aims. To find the place for the next conference.

4. On the basis of the reports and communications presented, to ask the Organizing Committee of the Conference to prepare "The request of the Conference to all organizations, enterprises and authorities regulating economic activity on the northern territories". To pass the "request" over to the international journal "Environment, Resources and Management", various ecological and biological publications in the USSR, and editorial offices of local and republican newspapers of northern regions.

5. To ask the Commission to compile a list of basic enterprises, organizations and scientific groups working at the problem of northern ecosystems reconstruction and to have the plans of their perspective investigations. From 1993 on the basis of informational accounts to issue a yearly review of the information obtained on the "Problems of Northern Ecosystems Reconstruction".

6. The Conference recommends to develop complex investigations concerning ecological-economic estimation of great industrial enterprises construction. The Conference asks the executive republican, regional and local bodies to allocate for this purpose definite sums from their budgets and to organize monitoring of the environment on their territories.

7. The Conference addresses the State Committee of RSFR on the problems of science and higher school, Presidium of the USSR Academy of Sciences with the request for the priority in financing research work, project and constructing works concerning methods on the estimation of complex compensation for the damage caused to natural sites as a results of different industrial and other kinds of human activity. Primary support should be also given to investigations aimed at the development of technologies with smaller-waste and non-waste systems.

8. The Conference asks all legislative bodies to lawfully forbid the construction of great industrial and civil projects without preliminary independent ecological examination.

The participants of the Conference express gratitude to the Institute of Biology, Komi Science Centre, Ural Division of the USSR Academy of Science and Syktyvkar State University for support and all the obligations connected with the work of the participants of the International Conference held in Syktyvkar, their accommodation and rest.

Accepted at the Closing Session.

July 11, 1991